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Important Books Received

Higher education in America. Edited by Raymond A. Kent, President of the University of Louisville, with twenty-two collaborators. (Chapter V: *The school of dentistry*, by William J. Gies.) 1930: pp. 689; 6¾ x 4 in.; 32 illustrations; $4.00. Ginn and Company, Boston, Mass.

Prosthetic dentistry. An encyclopedia of full and partial denture prosthesis. By Ira Goodsell Nichols, D.D.S., Lieutenant Commander, DC-V(S), USNR, Special Lecturer and Instructor in Dental Prosthesis, Dental Department, U. S. Naval Medical School, Washington, D. C., with collaboration of forty-five authorities. 1930: pp. 687; 8 x 5 in.; 830 illustrations; $12.50. C. V. Mosby Co., St. Louis, Mo.

Personal and community health. By Clair Elsmere Turner, M.A., Dr. P.H., Professor of Biology and Public Health, Massachusetts Institute of Technology; formerly Associate Professor of Hygiene, Tufts College Medical and Dental Schools. *Third edition.* 1930: pp. 443; 6½ x 3¾ in.; 62 illustrations; $2.75. C. V. Mosby Co., St. Louis, Mo.

Dietetics and nutrition. By Maude A. Perry, B.S., formerly Director of Dietetics: Michael Reese Hospital, Chicago, Ill., and Montreal General Hospital, Montreal, Can. 1930: pp. 332; 6 x 3¾ in.; no illustrations; $2.50. C. V. Mosby Co., St. Louis, Mo.

Special cavity preparations and casting processes for gold inlays. By Harry Ernest Bulyea, D.M.D., Professor of Operative Dentistry, Department of Dentistry, University of Alberta. 1930: pp. 30; 7¼ x 4¼ in.; 17 illustrations. *Bulletin Number 12*, Canadian Dental Research Foundation. Toronto, Can.

Ultra-violet rays. Their application in the practice of dentistry. By Robert J. Reade, M.A., M.D., C.M., D.D.S. 1929: pp. 31; 7¼ x 4¼ in.; 6 illustrations. *Bulletin Number 13*, Canadian Dental Research Foundation, Toronto, Can.

Annual report of investigations by the Therapeutic Research Committee of the Council on Pharmacy and Chemistry of the American Medical Association. *Vol. XVIII;* 22 assembled reprints; 1929. American Medical Association, Chicago, Ill.

Annals of the Pickett-Thomson Research Laboratory. Vol. V. The pathogenic streptococci; their rôle in human and animal disease (continued). Three parts on the rôle of the streptococci: in oral and dental sepsis; in tonsilitis and pharyngitis; and in puerperal sepsis and septic abortion. By David Thomson, O.B.E., M.B., Ch.B. (Edin.), D.P.H. (Camb.), Hon. Director, Pickett-Thomson Research Laboratory, St. Paul's Hospital, London; and Robert Thomson, M.B., Ch.B. (Edin.), Pathologist to the Pickett-Thomson Research Laboratory. 1929: pp. 484; 8¾ x 6 in.; 49 illustrations. Baillière, Tindall and Cox, London, England.

The physiology of oral hygiene and recent research, with special reference to accessory food factors and the incidence of dental caries. By J. Sim Wallace, D.Sc., M.D., L.D.S., Lecturer on Preventive Dentistry, King's College Hospital; formerly Dental Surgeon and Lecturer on Dental Surgery and Pathology, London Hospital. *Second edition.* 1929: pp. 228; 6½ x 3½ in.; seven illustrations. Baillière, Tindall and Cox, 7 and 8, Henrietta St., Covent Garden, London, England.

Christian and Jew. A symposium for better understanding. By thirty-six contributors; edited by Isaac Landman. 1929: pp. 374; 6½ x 3½ in.; 37 illustrations (portraits). Horace Liveright, New York.

An outline of oral surgery for the general dental practitioner. By James L. Zemsky, D.D.S., Attending Oral Surgeon to the Midtown Hospital, New York. 1930: pp. 171; 6 ¾ x 4 in.; 116 illustrations; $4.50. Physicians and Surgeons Book Co., Brooklyn, N. Y.

Oral diseases: a practical treatise offering diagnostic and therapeutic aid to the practitioner of medicine and dentistry. By James L. Zemsky, D.D.S., Attending Oral Surgeon to the Midtown Hospital, New York. 1930: pp. 402; 6¾ x 4 in.; 414 illustrations; $8.00. Physicians and Surgeons Book Co., Brooklyn, N. Y.

Necrotic gingivitis (trench mouth). By Harold Keith Box, D.D.S., Ph.D., Research Professor of Periodontology, Faculty of Dentistry, University of Toronto. 1930: pp. 64; 7 x 4½ in.; 18 illustrations. University of Toronto Press, Toronto, Canada.

Those teeth of yours. By J. Menzies Campbell, L.D.S., D.D.S., F.R.S.E., F.I.C.D., Fellow of the Royal Society of Medicine. 1929: pp. 141; 5½ x 3½ in.; 17 illustrations; 3/6 net. William Heinemann, Ltd., 99, Great Russell St., London, W.C.I., England.

Infant nutrition. By William McKim Marriott, B.S., M.D., Professor of Pediatrics, School of Medicine, Washington University. 1930: pp. 375; 7¼ x 4¾ in.; 55 illustrations; $5.50. C. V. Mosby Company, St. Louis, Mo.

Rickets including osteomalacia and tetany. By Alfred F. Hess, M.D., Clinical Professor of Pediatrics, University and Bellevue Hospital Medical College, New York City. 1929: pp. 485; 7¼ x 4 in.; 52 illustrations; $5.50. Lea and Febiger, Philadelphia, Pa.

Synopsis of the practice of preventive medicine as applied in the basic medical sciences and clinical instruction at the Harvard Medical School. By the Faculty of Medicine. 1929: pp. 194; 6½ x 3¾ in.; no illustrations. Harvard University Press, Cambridge, Mass.

The properties and uses of drugs. By Henry H. Rusby, Ph.M., M.D., D.Sc., Dean and Professor of Materia Medica, College of Pharmacy, Columbia University; A. Richard Bliss, Jr., A.M., Phar. D., M.D., Dean of the School of Pharmacy, and Chief of the Division of Pharmacology and Materia Medica, Colleges of Medicine and Dentistry and School of Pharmacy, University of Tennessee; and Charles W. Ballard, A.M., Phar. D., Ph.D., Associate Professor of Materia Medica and Director of the Microscopical Laboratory, College of Pharmacy, Columbia University. 1930: pp. 823; 7¾ x 4¾ in.; 38 illustrations; $6.50. P. Blakiston's Son and Co., Philadelphia, Pa.

American illustrated medical dictionary. A complete dictionary of the terms used in medicine, surgery, dentistry, pharmacy, chemistry, nursing, veterinary science, biology, medical biography, etc. By W. A. Newman Dorland, A.M., M.D., F.A.C.S., member of the Committee on Nomenclature and Classification of Diseases, American Medical Association, and Editor of the "American Pocket Medical Dictionary"; with the collaboration of E. C. L. Miller, M.D., Professor of Bacteriology and Biochemistry, Medical College of Virginia. *Fifteenth edition.* 1929: pp. 1427; 8¼ x 4¾ in.; 525 illustrations; flexible binding—plain, $7.00; thumb index, $7.50. W. B. Saunders Company, Philadelphia and London.

Fundamentals of pathology. By Joseph Schroff, B.S., M.D., D.D.S., Associate Professor of Oral Pathology, School of Dental and Oral Surgery, Columbia University. 1929: pp. 109; 7¼ x 4¼ in.; 40 illustrations; $2.50. William Albert Broder, New York City.

Outline of bacteriology. By Henry A. Bartels, B.S., D.D.S., Lecturer on Bacteriology, School of Oral Hygiene, Columbia University. 1929: pp. 128; 6¾ x 4 in.; 47 illustrations; $2.00. William Albert Broder, New York City.

SCHOOL HEALTH RESEARCH MONOGRAPH NUMBER III, OF THE AMERICAN CHILD HEALTH ASSOCIATION, ENTITLED "PUBLIC HEALTH ASPECTS OF DENTAL DECAY IN CHILDREN"[1]

An Analysis, a Protest, and a Correction

ORAL HYGIENE COMMITTEE OF GREATER NEW YORK[2]

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[1] This Monograph, published by the American Child Health Association (370 Seventh Avenue, New York City), appears to be intended as a contribution to the National Child Health Program now being developed under the guidance of the President of the United States. According to the Foreword (pp. vii–ix), the Monograph "is the third of the School Health Research Monographs in which are being presented the results of the School Health Study of the American Child Health Association. . . . When . . . . in 1926 Mr. Hoover, president of the American Child Health Association, suggested an investigation of school health programs, it was decided to make of this study an evaluation or measurement of the effectiveness of what was being done. . . . This third monograph is contributory to the development of an evaluation formula which may be applied to results. . . . for the purpose of determining the efficacy of one phase of the procedures which make up the school health program."—[*Ed.*]

[2] The Oral Hygiene Committee of Greater New York consists of a total of seventeen representatives of nine local organizations, as follows: *First District Dental Society* (Manhattan and Bronx), Lillian Barkann, Waldo H. Mork, Jacob B. Schneer, Wallace T.

I. ABSTRACT OF A REPORT BY A SUB-COMMITTEE OF THE ORAL HYGIENE COMMITTEE

This report presents (a) a very general review of Monograph III; (b) a series of fifteen quotations followed by comment expressive of some of the sub-committee's dissent; (c) general remarks on the unreliability of the Monograph; (d) a recommendation as to procedure; (e) and an appendix indicating changes in the condition of the first permanent molars in some school children as noted thirteen months after their examination for the record in Monograph III.

The sub-committee's comment, under the fifteen illustrative quotations, shows that the Monograph is almost wholly destructive in intent and presentation. Ignoring past researches, disregarding clinical observations and experience, and misrepresenting current practice, the Monograph publishes opinions, assumptions, conclusions, and advice, which, if well founded, would soon undermine present endeavors to promote oral health-service in public schools, and would also block all new efforts to this end. If allowed to go uncorrected, the unwarranted statements in the Monograph would degrade dentistry in public respect, impair the usefulness and opportunities of dentistry in health service in general, discourage public support of dental participation in public-health work, and retard the current improvement of coöperation, and of understanding and esteem, between dentists and physicians.

Much that the Monograph contains is a mathematical demonstration of well known facts, including the obvious. The mathematical technology of the Monograph, while giving the author's presentation the appearance of exceptional accuracy, has not disguised the mathematical inadequacies. The illustrative quotations, on which the report is focused, consist chiefly of conclusions based presumably on careful mathematical analyses of data obtained accurately and without bias. But there are numerous contradictions

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Van Winkle, Dwight R. Wilson; *Second District Dental Society* (Brooklyn, Queens, Richmond), Arthur J. Brennan, William M. Burns, Charles H. Dunlop, H. Shirley Dwyer, Harold S. Horton; *Allied Dental Council*, Morris B. Rubin; *Eastern District Dental Society*, Henry Spenadel; *Harlem Dental Society*, Joseph H. Kauffmann; *Kings County Dental Society*, Maurice William; *Northern District Dental Society*, Kannon Sheinman; *Queens County Dental Society*, Irving Spenadel; *Dental Hygienists Association*, Mrs. Helen C. MacNally; *Executive Secretary*, Clare Terwilliger. For about fifteen years, at monthly meetings, the Oral Hygiene Committee has been giving constructive attention to the advancement of preventive dentistry, and to the promotion of the public interests in oral health-service. Realizing the importance of the Sub-committee's report, but appreciating the fact that it would have a broader public significance if it merited approval by the official representatives of the whole dental profession in the United States, copies were submitted by the Oral Hygiene Committee to the seventeen members of the Board of Trustees of the American Dental Association in advance of their sessions in Denver, July 18–25, 1930. Related resolutions adopted by the American Dental Association, and other professional groups in session at Denver during the same period, in general agreement with the findings of the Oral Hygiene Committee, are published on pages 544–546.—[*Ed.*]

[1] The intimation in the concluding paragraph of the Foreword of Monograph III, that the Monograph satisfactorily expresses representative dental knowledge and opinion, is not supported by the action of these national dental organizations.

and inconsistencies; nonsense and misinformation are conspicuous; and there is a suspicious selection of data to support favored conclusions—all savoring of prejudice. Essentials of procedure have been omitted from the record, which alone renders the Monograph unreliable. A ludicrous method of distinguishing three arbitrary types of "observable" enamel defects was used, one of which types is called "protective" and another type, "considered as *caries*," is naïvely recorded as occurring frequently in "*non-carious*" teeth. And teeth *having no enamel defects* are said, on the basis of a faulty mathematical procedure, to be "*more liable*" to decay than those having defects!

In the illustrative quotations from the Monograph, it is asserted, and much is made of the statement, that there is important dental propaganda, directed at public-health administration, advocating a policy of filling deciduous teeth, to *protect the occlusal surfaces of first permanent molars against decay*. The author shows mathematically that such a result is unattainable in this way, and the dental profession is reprimanded for ignorance and presumption. But this alleged propaganda was never fostered under any responsible authorization, and dentistry has been deliberately or carelessly misrepresented. It is also said that prevention of dental caries is not being brought about, but well-known achievement in prevention is ignored. It is urged that carious teeth should be disregarded in such a research as that described, but it is obvious that knowledge of the prevalent location of caries, and of the situation of surfaces that commonly do not decay, is essential in such research. In an endeavor to show that the spread of caries is not due to local factors, the Monograph fails to distinguish between general *influences* and local *conditions* as *joint factors* in bringing about decay, although in other connections the author refers, unwittingly it seems, to local conditions as effective in this respect. But he also concludes that "decay is periodic—a peculiarity of the individual organism and *not the tooth*." Yet he would check "waves of *influence*" that bring about decay "by filling the cavities" caused by the decay! As for pits and fissures in enamel, the Monograph urges that nothing be done about them until they decay, because, owing to a mystic "organic immunity" that is presumed to protect *some* defects against caries, one cannot be sure which defects *might not* decay.

The Monograph does not recommend an effective school dental-health policy, the author appearing to be satisfied with anything less that may be required by indifferent support, or mediocre service, or both. A do-nothing policy, as affecting dentistry, is a logical implication from his conclusions. If the Monograph had been intended to avoid constructive suggestions, to misrepresent current dental practice, and to degrade dentistry in public confidence, it would have been difficult to devise it more adroitly for the achievement of these aims.

Results beneficial to the health and well-being of school children, improvement in their deportment, and reduction of retardation in their school progress with less waste of the taxpayer's financial contribution to public welfare, as assured consequences of an effective oral health policy in schools, have apparently not interested the American Child Health Association. The Monograph totally ignores these well established facts, although there are thousands of authentic instances of such results of dental health-service for children in public schools. Yet the American Child Health Association has the temerity to present Monograph III as an authoritative publication on "Public *health* aspects of dental decay in children." Would not a more appropriate title have been: "A mathematical obfuscation of some well known facts relating to dentistry for children?"

II. REPORT OF A SUB-COMMITTEE OF THE ORAL HYGIENE COMMITTEE[4]

A. General review of Monograph Number III

Monograph Number III, entitled "*Public health aspects of dental decay in children,*" consists of a Foreword of 3 pages (vii–ix), a text of 67 pages, an Appendix of 51 pages, but no index—a total of 121 pages. The text is divided into six chapters bearing the following captions:

"Chapter I. Measurable aspects of oral hygiene"
"Chapter II. Continuity of decay"
"Chapter III. Effect of fillings upon dental decay"
"Chapter IV. Relation of enamel defect to school health policy"
"Chapter V. Stain, tartar, and gingivitis"
"Chapter VI. Application of the conclusions to the problem of dental measurement"

The *Foreword* states that the series of monographs, of which this on dental decay is the third,

"*arose* out of the growing realization, particularly among educators, that the accumulation of definite evidence of cause and effect relationships was essential to the progress of the school health program. Other things being equal, do school children who have been the recipients of an extensive school health program give tangible evidence of the effects of that program, in contrast to school children who have not had such attention in the schools? . . . . In the field of dental hygiene . . . . [a preliminary] survey indicated the complete lack of a common understanding of which procedures, if any, really help to solve the serious problem of dental decay. With the best of intentions health work was being done to attain certain ends, but whether or not those ends were attained was not known" (Foreword, page vii).

On the *general nature and basis* of the study outlined in the Monograph, the author wrote that it was

[4] Presented, at a special meeting of the Oral Hygiene Committee of Greater New York, on June 26, 1930, by the *Sub-committee*: H. Shirley Dwyer, Thaddeus P. Hyatt, William J. Gies, Kannon Sheinman, and Maurice William.

"primarily an intensive analysis of the first molars and the second bicuspids, or their precursors, the deciduous second molars, in a random group of ten-, eleven-, and twelve-year-old American born white children measured [during the course of the school year 1927–28, in seventy different cities in thirty-eight states] by dental hygienists of the School Health Study field squads" (page 4). . . . "The problems met with in this study are all grounded in the interrelations of teeth in respect to decay. In order to study certain effects of the influences which bring about decay, the method chosen was to find the degree to which filled and unfilled caries in one tooth are associated with filled and unfilled caries in another. The mathematical measure used was the product moment correlation coefficient. The conclusions reached in this monograph and the accuracy of the formula chosen for the evaluation of dental health in the School Health Study depend upon an interpretation of this coefficient" (page 7).

The *main stated conclusions* in the Monograph, of greatest interest to the Oral Hygiene Committee, are quoted in the following summary:

"Correlations between carious condition of teeth in horizontal relation to each other are considerably higher than between those in vertical or diagonal relation" (Chapter I, page 10).

"Decay is periodic and . . . . a function of the individual organism and not the tooth" (Chapter II, pages 19–20).

"Present dental correction is palliative and not either preventive or curative" (Chapter III, page 39).

"We were . . . . unable to distinguish first molars which are liable to caries from others not liable to decay. First molars which seemed to our observers to have no enamel defects were more liable to caries than were those which could be described by them in terms of pit and fissure. (*Author's footnote*: This probably means that the enamel defects which are many times smaller than a tooth brush bristle escaped our examiners in spite of all possible vigilance.) First molars which had escaped caries at age twelve were found to have as much enamel defect as non-carious first molars in the mouths of six-year-old children. It is almost certain that school health programs could not rely on getting better recognition of liability to caries than that found in our experiment, unless criteria are added which were unavailable to us" (Chapter IV, page 48).

"Cleaning teeth as it is done by the dental hygienist may have its own values, aesthetic or educational, but the absence of stain is not associated with the absence of caries, nor is the presence of stain found to go hand in

hand with caries. . . . Removal of stain as here measured cannot be expected to protect the child against caries" (Chapter V, pages 54–55). . . . "Stain as measured is unrelated to tartar, gingivitis, or uncorrected caries. Tartar is related to gingivitis but not to caries" (Chapter V, page 56).

The *Appendix* presents technical and statistical data, and extends and illustrates the mathematical basis of the interpretations and the conclusions.

Although Monograph III is entitled "*Public health aspects of dental decay in children*," one looks in vain for a discussion of this subject. But there are statements to the effect that dentistry is not preventing dental decay in children, and that therefore public-health programs and school health-administrators should not attempt such prevention until "the problems of predisposition and cause" (page 39) will have been solved by further research.

The author refers only to the researches of the School Health Study of the American Child Health Association. He does not allude to any of the investigations or data upon which are founded current public-health efforts to prevent dental decay in children. He occasionally admits that his views and data are of importance to school health administration, the present policies of which he intimates should not include dental service.

It is deeply gratifying to find that the American Child Health Association, seeking to promote the public welfare and regarding dental decay as a "serious problem," has subjected dental caries to a special study. We note with great interest, also, that this important disorder is one of the first to receive attention in the Association's series of Monographs. Much that the Monograph presents is well known. We have no reason to doubt the validity of the mathematical processes described and applied, nor of the calculations presented, as relating to the particular records in the Monograph. But we are regretfully obliged to take exception to a number of the interpretations and deductions, because they conflict with reality, scientific knowledge, and clinical experience. Some of our dissent is indicated below in comment under the following fifteen quotations from Monograph III.

B. Preliminary analysis (quotations with comment)

Quotation 1. *"One section of this monograph deals with the effect upon decay in permanent molars exercised by filling of deciduous molars. . . . We are. . . .faced with propaganda directed at public health administration and claiming that a policy of filling deciduous teeth will protect the first molars against decay.* (Author's footnote: *These claims are made with regard to the frequent occlusal caries and not only to the infrequent decay on the sides of the permanent molars.*) *Our data are organized to critically examine such advice and are here presented in order that public health administrators may be equipped to judge the value of these arguments" (pages 2 and 3).*

The quality of the understanding on which the Monograph is based, and the attitude and inclination of its authorship, are clearly indicated by the pretended existence of responsible "propaganda" for filling deciduous teeth to protect the occlusal surfaces of first permanent molars against decay. Evidently this unwarranted and misleading statement is presented at the beginning of the Monograph to illustrate, for the reliant reader, the value and the significance of the author's methods and conclusions. It is accompanied by a pretentious array of data purporting to show that such propaganda is without foundation, thus tending, especially for lay readers, to give the author fictitious dependability as an interpreter and also to destroy the confidence of public-health administrators in public-health-education propaganda as actually conducted by dental organizations. This procedure in Monograph III is indifferent to the cause of child health that the Association was organized to promote. It is unjust to the dental profession, and wholly unworthy of any serious scientific research. The ludicrous view in Quotation 1 has never been endorsed by responsible dental organizations, which the American Child Health Association might have learned if it had consulted any one of them.

We deplore the fact that the private dental advisers of the American Child Health Association did not inform the Association and the author that the reasons given in official dental propaganda for "a policy of filling deciduous teeth" are these (a–c):

(a) The presence of carious teeth, with the myriads of infective

and putrefactive bacteria and their toxins, may undermine general health.

(b) The premature loss of deciduous teeth disturbs the natural development and growth of the jaws and head, with consequent crowding of permanent teeth and their ensuing misplacement.

(c) The presence of large carious cavities in deciduous teeth, by rendering mastication painful and thus impairing function, encourages development of the unhealthy habit of bolting food.

Quotation 2. "Present dental correction is palliative and not either preventive or curative. . . . A real preventive program awaits solution of the problems of predisposition and cause" (page 39).

Quotation 2 appears in the summary on the "effect of fillings upon dental decay." The author also says: "The data in this chapter [III] comprise an evaluation of fillings *as made in a representative sampling of American born white children.* . . . . . Administrators responsible for school health policies wish to know just what is done for health by fillings *as they are generally made.* Our treatment in this chapter intends to throw light on this question" (pages 38 and 39: italic not in the original). Quotation 2 is clearly intended by the author to refer to current *dental practice in general.* The conclusion in Quotation 2, the author says, "arises from this analysis" of his data (page 39):

"1. The chances for further development of caries in any one tooth are smaller when previous decay in that tooth has been corrected."

"2. Filling deciduous teeth has no apparent effect upon the subsequent or contemporary decay of permanent teeth. (*Author's footnote*: This refers to caries wherever found in the tooth and does not give special consideration to caries on adjacent approximal surfaces.)"

"3. Corrective work on any one first molar has no effect upon total decay in the others. The proportion of total decay which is corrected affects only the proportion corrected in the other teeth because of actual contemporary work, but does not cut down the total decay in these others."

The sweeping negative conclusion in Quotation 2 relating to *prevention* is not warranted by any data in Monograph III, and ignores well-known facts. If allowed to stand uncorrected, it would seriously retard the progress of oral health-service for children, mislead "administrators responsible for school health policies," and misrepresent the capabilities of modern dentistry.

Although various ordinary and apparently harmless bodily conditions tend to develop into states of disease, the medical profession keeps before the public the fact that these consequent disorders may be prevented by suitable and timely intervention. Thus, as an example, there is useful medical propaganda (a) to show, from data obtained in a study of adults, that various lumps, swellings, tumors, etc., although seemingly unimportant departures from normal, tend to evolve into cancer, and (b) urging that physicians be consulted regarding them so that these "growths" may be surgically removed *before* this pathological change can begin. In such cases, surgeons, in order to remove *all* "growths" that would *probably* become cancerous if left in place, are obliged also to excise *some* that *might* remain completely harmless if undisturbed, thus engaging in "operative interference on many units merely because it prevents disease in some," which the author concludes "is not sound policy" (page 49). Although this surgical program "in the fight against cancer" is not based upon a "solution of the problems of predisposition and cause," neither of which has been determined, nevertheless, it has been the means of accomplishing real prevention of cancer. No one would seriously suggest that this surgical plan should be rejected because a better method of prevention may ultimately be discovered.

Current methods of prevention of dental caries include an analogous illustration. For nearly 100 years dentists have known that minute imperfections are common in the occlusal surfaces of permanent molars at the time of eruption, and that these enamel defects if left uncorrected will *probably* soon thereafter begin to decay. Accordingly, dentists urge that children be presented shortly after the eruption of these teeth, so that any such defective surfaces may be excised sufficiently to remove the faulty tissue, and the ensuing tiny cavities filled in a way, and with material, to prevent the *initiation* of decay where otherwise it would *probably* soon begin. Under these circumstances, however, dentists, to afford the greatest measure of protection—facing obligations and uncertainties like those of the surgeon in removing precancerous "growths" for the prevention of cancer—must also excise *some* enamel defects on these surfaces where decay *might* not develop. In the surgical effort to prevent cancer or caries, the patient receives the benefit of the doubt where it may exist, not the involved tissue.

The medical and dental professions are keenly aware of the need for greater effort, larger financial support, and more successful research for the complete solution of all problems of prevention, so that, for disease in every relation and for every individual, complete prevention will be invariably successful, and all variations and peculiarities automatically included. Unfortunately the health millenium is not yet at hand. While its advent is awaited, the best available facilities for prevention, whether empirical or scientific, partial or complete, variable or invariable, must be used and should be developed as the most effective means at hand in their respective applications.

Quotation 3. "Recommendations for school health policy. . . . sometimes must diverge considerably from current practice" (page 2).

Here, and in associated comment in Monograph III, there is no recognition of the obvious fact that where *health* is at stake, the obligations of public-health agencies, of practitioners in public-health work, and of practitioners in private service, are identical. The angle of elevation of this Monograph is further indicated by this comment on page 25: "From a public health point of view the question is, 'What does dental work as now generally available contribute to public health?' and not, 'What could the best type of dental practice do?' In this study we are concerned with the first and not the second of these two questions." The Monograph does not aim to show what should and could be done, in a public dental-health program, for the protection of teeth against decay, nor does it present constructive criticisms of current deficiencies in funds or personnel, or otherwise, which, in the public interest, should be overcome, and which such criticism might help to rectify. Instead, the author seems to believe that such an effort would not be practical. Apparently, in his opinion, *recommendations* for a public-school health policy should suggest not plans for the most complete and effective protection of child health, but merely anything less that would be conveniently available under prevailing conditions, whatever they might happen to be. In this view, a policy passable today would also be acceptable years hence—nothing should be done to effect improvement; things as they are might be worse; adopt the easiest way, not the most desirable method.

Quotation 4. "It may be proper policy for a dentist to examine, cut

out, and fill the grooves [*sic*] *on the occlusal surfaces of the first molars no matter what criteria he uses to distinguish teeth that shall be so fortified. It is, however, definitely bad public health policy to inaugurate a widespread practice of this kind unless it is possible to lay down a definite manner of finding those occlusal surfaces of first molars which are liable to caries and those others which are not*" (*page 2*).

Here the author of Monograph III, *to illustrate* the intended import of Quotation 3, refers to the method for prevention of dental decay that was mentioned in our comment under Quotation 2.

By the expression "examine, cut out, and fill the grooves [sic] on the occlusal surfaces of the first molars," it appears that, despite the presumed mathematical accuracy of the Monograph, the author meant to refer to *pits and fissures*, which are defects, and not to "grooves," which are normal formations. Furthermore, the author seems to use "occlusal surfaces" in one place to mean *defects or faults* in occlusal surfaces.

The word "liable" is employed in Quotation 4, and often elsewhere in the Monograph, apparently to express an active tendency in a tooth to decay rather than to indicate that a tooth is passively *subject, or exposed*, to factors that induce decay. Each occlusal pit or fissure is *liable* to decay, and *will* decay, if the *influence* that causes decay is brought by favorable *conditions* to act upon the pit or fissure. We assume therefore that, in Quotation 4, the author meant to suggest a distinction between enamel defects that *probably* will become carious and those that *might* not. On page 48 he states: "Every effort was expended to make the best use of training, supervision, and consultation with dentists in the observations. . . . We were, nevertheless, unable to distinguish first molars which are liable to caries [will become carious?] from others not liable to decay [will not become carious?]. First molars which seemed to our observers to have no enamel defects were more liable to caries [more frequently carious?] than were those which could be described by them in terms of pit and fissure. (*Author's footnote:* This probably means that the enamel defects which are many times smaller than a tooth brush bristle escaped our examiners in spite of all possible vigilance.)" There is no evidence in the Monograph of any recurrent examination of the same children and teeth to justify these conclusions, which in the main appear to indicate predictions rather than observed conditions.

Regarding the practicability of recognizing dangerous enamel defects, and its relation to a school program of prevention, we call attention to well known facts. Some enamel defects may be so minute that they cannot be easily detected, but their proportion is so small, compared with the larger number that can be, that it would be inexcusable to do nothing about those that can be found. Not every enamel defect becomes carious, but the majority that will certainly soon harbor decay is so large that, to prevent caries in these, an operative preventive procedure relating to them is necessary where health is the primary consideration. Histological research and clinical experience have provided a sound basis for this preventive surgical intervention. The dental profession believes that adequate diet and hygienic living greatly reduce the incidence of dental caries *and of some other diseases as well. Perhaps* adequate diet and hygienic living would make vaccination unnecessary. But this remote "Perhaps" would not justify discontinuance of vaccination as a general means of prevention—a means which, because of present uncertainties, must be applied to all in a community to protect each of those who otherwise would *probably* have small pox even though some *might* not. No one knows how many thousands of children have been vaccinated, and thus given protection against small pox, who without vaccination never would have had the disease. Would the author of Monograph III urge that vaccination should be discontinued until, as he recommends in the case of dental decay, the "problems of predisposition" will have been solved, or for the reason that "operative interference on many units merely because it prevents disease in some" is "not sound policy?"

A very important factor in any public dental-health policy, which is not indicated in Monograph III, is the striking dissimilarity in the incidence and progress of dental caries on two types of tooth surfaces. It is safe to *wait* for the first signs of caries on *smooth* surfaces, where in its progress the cavity in the enamel assumes a V-shape, with the apex toward the dento-enamel junction. Such a cavity, even when very minute, may readily be detected. Therefore it is always easy to recognize caries at its incipiency on *smooth* surfaces. The initiation and progress of a pit- or fissure-decay, however, may be very difficult to detect because the occlusal surface is usually not visibly

affected; and the decay, proceeding inward along the sides of a pit or fissure and into the dentin underneath, gives the cavity there a V-shape with the apex toward the surface of the enamel. Usually such *sub-enamel* decay does not give *clinical* evidence of its presence or progress until it has insidiously undermined the enamel and a cave-in takes place. By this time, however, the decay has usually penetrated deeply into the structure of the tooth, and pulp infection is often in progress.

As a result of the prevalence of caries: at the age of twenty, 36 percent of first molars are missing; at twenty-four, 41 percent; at twenty-nine, 48 percent. A simple way to *prevent* much of the insidious decay responsible for these serious consequences was noted in our comment under Quotation 2. In Monograph III, however, we are advised that this simple and inexpensive preventive work should not be attempted because it is impossible to distinguish between the defects that *will* certainly decay and those that *might* not. According to Monograph III, supposedly devoted to promotion of public health, the minute masses of enamel tissue affected by this uncertainty, rather than the child, should be given the benefit of the doubt. Wait until the enamel roof caves in to be sure to learn what to do! The health of the child! What an impractical consideration in a monograph on child health.

As for the difficulty in making the distinctions mentioned in Quotation 4, and its assumed insurmountability, it will be sufficient for this report to add that procedures for this diagnosis have been conducted successfully in public schools not only by the Oral Hygiene Committee of Greater New York, but also by many dental authorities.

Quotation 5. *"Great care was taken in the selection and training of the dental hygienists who acted as observers in order that distinctions made by any one were like those made by the others.* (Author's footnote: *Six dental hygienists and a dentist were employed in the preliminary weeks of experimentation to obtain adequate training and objectivity in the distinctions. The data were finally gathered by two dental hygienists.*) *From checks made on these observers it was determined that records of enamel defects in the four first molars are the same for any child independent of examiner. Correlations between examiners are around 0.90"* (*page 43*).

There is no indication in this statement of the method used to establish the ability and constancy claimed for the observers, such as should be the basis for the sharp mathematical distinctions in the Monograph. The reader is given no opportunity to evaluate the means employed. "Checks made" may mean much or little. There is no *evidence* of any particular establishment of ability in the "observers" *uniformly* to detect the presence of pits and fissures and to classify them as directed and claimed. It is said that "great care was taken. . . . in order that distinctions made by any one were like those made by the others." But this general statement, without an indication of the procedure adopted for the purpose, does not inform the reader, who in this regard is left completely in the dark. The same vague assurance might be given, for an experiment on color distinctions, about color-blind examiners—their deficiencies might be the same and their color judgments therefore identical—but they might be blind, say, for red!

The very brief and indefinite allusions to the ability and constancy of the "observers" in their records of pits and fissures contrasts markedly with the three pages of discussions, explanations, and illustrations in this relation on the "measurements made of stain, tartar, and conditions of gingiva" (pages 50–53), in which the "observers" showed disagreement, and regarding which the author says: "Our *estimates of decay are much better*" (page 50).

On pages 54 and 55, the author of the Monograph wrote: "There is absolutely no relation between either stain or tartar and the development of caries. . . . . The absence of stain is not associated with the absence of caries, nor is the presence of stain found to go hand in hand with caries. . . . Removal of stain as here measured cannot be expected to protect the child against caries." "Stain" in this statement is used very indefinitely. On page 74 stain is referred to as having "thickness or heaviness," and it is said that "food deposits that are loosely or readily brushed off with the explorer are not recorded as stain. No classification for deposits other than stain or tartar is used." By "stain" the author appears to mean colored deposits that were thick or heavy enough to be *obvious*, and does not include invisible mucinous or other bacterial deposits that are commonly revealed by the use of "disclosing" stain, and which are inti-

mately related to the initiation of caries on some surfaces. The preventive effect of the removal of deposits that are revealed by "disclosing" stain has not been considered in the study described in the Monograph, and therefore the intimation on pages 54–55, that "cleaning teeth as it is done by the dental hygienist" has no preventive value, is incompetent and irrelevant.

The measurements of stain were made by the use of rating scales, which, the author concedes, "are always less satisfactory than other types of measurement. Our estimates of decay are much better," he says, "since they are spatial and so depend upon tangible sensory experience" (page 50). On pages 51 and 53 it is said: "The dental hygienist. . . . in the southern squad (A) is constantly higher in reported stain and tartar. This is due to unremoved differences in standard between the examiners. There is in addition *a very obvious tendency for each of the examiners to change her standards as she gets further away from the base of training.* We believe these tendencies are unavoidable when rating scales are used." (Italic not in the original.) The facts in these allusions by the author of the Monograph, to the unreliability of his records in this relation, should have induced him to omit the chapter on this subject.

Quotation 6. "In presenting separately the results for each of the six types [of enamel defect]. . . . the protective influence of Types 1 and 2 may be judged entirely independent of Type 3" (page 45).

In this statement there is an obvious contradiction in terms. The author's use of the word "protective" implies a view of the relation of enamel defects to decay and to one another that is not only unique, but also unsupported by any known morphological or functional facts. A defect in enamel, like a defect in any other structure, is obviously an actual or potential weakness and deficiency, not in any sense a condition of strength or "protection."

The deep fog or Pickwickian atmosphere in which much of the work was done, and the Monograph written, is indicated in many places, but is well illustrated by the yes-and-no allusions to the significance of pits and fissures of "Type 3." Thus, on page 44, it is said that "Type 3 (pit or fissure) may be considered as caries"; on page 45, that "Type 3 pit and Type 3 fissure may be considered as caries." Yet Table 20 on page 45, and Charts III and IV on pages 46 and 47, which are said to

present the average numbers of pits and fissures as recorded only for *non-carious* first permanent molars at different ages, *include also the number for Type 3!* Just how *caries* can exist in a tooth while that tooth is *non-carious* we are unable to imagine, but possibly such problems can easily be solved with the aid of mathematical equations. On page 76 of the Monograph we read: "Type 3 is an occlusal pit . . . . [that] may be regarded as first degree caries;" on page 77, "Type 3 is an occlusal fissure . . . . [that] may be regarded as first degree caries." But in the last footnote on page 76 the following is stated regarding "Type 3 pit:" "The apparent softening of the base or walls of the enamel [the distinguishing feature of Type 3 defects], as evidenced by the *resistance* to the explorer, may indicate beginning caries. However, *such evidence cannot be accurately diagnosed as caries by this method* and, therefore, the enamel defects are considered by separate types. Of course, if [sic] such conditions do represent caries they are undoubtedly [sic] the early observable evidences of caries occurring at the site of recognizable enamel defects." (Italic not in the original.)

It seems evident that, as the author of Monograph III had no clear conception of the nature or import of the pits and fissures of his arbitrary types, the collaborating examiners were hardly more definite or uniform in their distinctions and classifications relating to these defects. In the present report we assume that the author's first allusion to Type 3, on page 44—as defects that "may be considered as caries"—was his most deliberate guess, and that he there intended to convey the idea that he and his examiners usually regarded defects of Type 3 as definitely carious, and as in fact representative of states of decay in the first permanent molars containing them.

Quotation 7. "*In order to study certain effects of the influences which bring about decay, the method chosen was to find the degree to which filled and unfilled caries in one tooth are associated with filled and unfilled caries in another*" (*page 7*). . . . "*Correlations between carious condition of teeth in horizontal relation to each other are considerably higher than between those in vertical or diagonal relation*" (*page 10*).

The author here betrays entire unfamiliarity with established conclusions of modern dental research. The *influences* that bring about decay, when present in the mouth, are *the same for all the teeth in all locations.* The correlation of decay in one tooth with decay in another

tooth is not a relation of cause and effect, but only of the *conditions* that support the influences that bring about decay. Between teeth of the *same kind*, the correlation is dependent upon similarity in the conformation, or in the structure, of the enamel at specific locations of decay. Between teeth of *different kinds*, or between different locations on a tooth, correlations are dependent upon the equal or almost equal degree of *liability* of the surfaces where the decay occurs. Thus, buccal caries in the lower *right* first molars can be associated only with buccal caries in the lower *left* first molars. The *conditions* that affect liability to decay in the *mesial* surface of an *upper* central incisor are different from the *conditions* that affect liability to decay in the *buccal* surface of a *lower* first molar. The number or size of filled or unfilled carious cavities in one tooth cannot be associated with the *influences* that bring about decay in another tooth, unless the *conditions* that help the influences to induce decay are similar. Bilaterality of liability is common to all teeth in horizontally opposite situations. The degree to which filled or unfilled caries in one tooth is associated with filled or unfilled caries in another tooth does not and cannot measure the *effect* of the *influences* of decay, but when all surfaces and all teeth are considered, the possibilities of an operative preventive procedure may be determined.

According to the author, the "correlations between carious condition of teeth in horizontal relation to each other are considerably higher than between those in vertical or diagonal relation" because of "similarities in time of eruption" and in "general organic bisymmetry" (page 20). This explanation is incomplete. When the conformation or structure of the enamel at a particular location on a tooth is such as to afford undisturbed retention of bacteria, for example, there is very frequently, in fact almost always, the same conformation or structure of the enamel in the similar location on the tooth horizontally opposite. It is within this *conformation or structure*, rather than elsewhere on these directly comparable teeth, that decay *more frequently* occurs. In these particular locations the different conditions and influences are respectively equal in kind and degree. There the influences, supported by the conditions, break down the enamel. Since the shape and structure of the various surfaces are not respectively similar for teeth of the same kind in a vertical or diagonal relation-

ship, equal degrees or correlations of frequency of decay are impossible for teeth of the same kind in a vertical or diagonal position.

These facts are well known to dentists. Information of this kind, which is useful for administrators of public-health policies because it aids them to understand why minute defects in the enamel ought to be filled at the earliest possible age, should have been presented in Monograph III, which has been offered to the public as a contribution on the public-health aspects of dental decay in children.

Quotation 8. "*The fact that such enamel liabilities as do occur, so frequently remain non-carious up to the age of twelve, is a strong reminder that there is such a thing as organic immunity which is not yet understood*" (*page 48*).

Among the explanations preceding this statement are these: "From the school health point of view the problem is whether or not it is possible practically to distinguish those enamel defects which will later become carious from those enamel defects which will not" (page 40). "In order to study the importance of this aspect of dental care we examined non-carious first molars in the mouths of children varying in age from six to thirteen. Of course, the older a group of children the more caries there will be in the first molars. (*Author's footnote:* If one were to seek the same number of non-carious teeth in the older age groups as in the younger ones, it would, of course, be necessary to examine more children of the older age groups"—page 41.) "It is obvious that carious teeth should not be considered in these observations of enamel defect, because the pits and fissures which have been involved in the caries cannot be known" (page 44).

In this part of the study, the author arbitrarily distinguished three kinds of pits and three kinds of fissures (page 44), designating the varieties in each trio as Type 1, Type 2, and Type 3, respectively. For each (pit or fissure), *Type 1* was the most minute ("the explorer—No. 6—wedges or catches"); Type 2 was larger than Type 1 ("tip of the fine explorer—No. 6—can be moved about . . . . not large enough to admit the two points of the closed pliers"—No. 12); Type 3 was "the same size and shape as Type 2, but with softening of the base or walls of the enamel fault . . . . *may be considered as caries*". The use of such crude means to distinguish types of enamel defects, the

obvious technical difficulties attending the differentiations, and the inadequacy of these procedures in dental practice, may account for the author's failure, as noted in the comment under Quotation 5, to indicate the method employed to insure uniformity of diagnostic judgment in the examiners.

Table 20 (page 45), which summarizes the most significant data on the average number of enamel defects of these arbitrary types in what are called "non-carious" or "healthy" first molars, is included in *Table 1*, on page 516 of the present report, where additional data have also been incorporated. Regarding some of the data in our *Table 1* that were taken from Table 20 in Monograph III, the author says (page 45): "If Type 2 tended to become Type 3 in otherwise healthy teeth as the children grow older, then there would be an increase in average incidence of the latter at the expense of the former." Then he adds: "This is not the case. There are no decreases in frequency of occurrence in any of the six types as age increases" (page 45). These opinions in Monograph III allude, however, not to the *same children at successive periods of observation* from age six to age thirteen, nor to *all* of the first molars in the children examined, but instead to different children examined once individually, and only to the so-called "healthy" or "non-carious" first molars remaining in a few of these children at the time of examination.

If, however, for *temporary* purposes of analysis, we a*ssume* with the author that each average in Table 20 (page 45) for enamel defects is truly representative of conditions in the corresponding age-groups, then we note also that the number of defects increases in sequence from Type 1 to Type 3 not only *horizontally*, for a given age as he stresses them, but also when followed diagonally downward to the right *in time* for *successive ages, as shown in Table 2*, page 517 of the present report. These relationships should have *suggested*, to an open-minded investigator, the *possibility* that, at the time the enamel defects were found, some unobserved defects were enlarging toward Type 1; some of Type 1 were becoming Type 2; and some of Type 2 were approaching Type 3. Nothing in Monograph III shows that this *possibility* was actually tested as a mathematical alternative, the author having apparently made no effort, from a study of a given group of children, to *exclude*

TABLE 1 (Includes Table 20 in Monograph III)

"Average number of pits and fissures distinguished for type in non-carious first molars at different ages;" with additional data

AGE	CHILDREN INVOLVED NO.	HEALTHY FIRST MOLARS EXAMINED NO.	FIRST MOLARS UNHEALTHY (CARIOUS) OR MISSING NO.	AVERAGE NUMBER OF *pits* PER TOOTH			AVERAGE NUMBER OF *fissures* PER TOOTH			AVERAGE TOTAL NUMBER OF EACH TYPE OF ENAMEL DEFECT PER "HEALTHY" FIRST MOLAR			AVERAGE TOTAL NUMBER OF ENAMEL DEFECTS OF THREE TYPES PER "HEALTHY" FIRST MOLAR	FIRST MOLARS, UNHEALTHY (CARIOUS) OR MISSING, PER CHILD	
				Type 1	Type 2	Type 3	Type 1	Type 2	Type 3	Type 1	Type 2	Type 3		Average number	Per cent
6	76	238	66	0.18	0.28	0.55	0.04	0.13	0.21	0.22	0.41	0.76	1.39	0.87	21.7
7	117	371	97	.17	.37	.53	.02	.08	.15	.19	.45	.68	1.32	0.83	20.7
8	116	354	110	.21	.26	.56	03	.09	.10	.24	.35	.66	1.24	0.95	23.7
9	121	364	120	.19	.36	.49	.04	.14	.15	.23	.50	.64	1.36	0.99	24.8
10	157	438	190	.23	.41	.61	.05	.10	.24	.28	.51	.85	1.64	1.21	30.3
11	179	475	241	.24	.36	.59	.04	.12	.19	.28	.48	.78	1.54	1.35	33.7
12	138	319	233	.30	.40	.54	.05	.10	.13	.35	.50	.67	1.52	1.69	42.2
13	74	173	123	.16	.30	.50	.03	.09	.14	.19	.39	.64	1.23	1.66	41.6
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

The columns are numbered at the bottom. Data in columns 1, 3, 5, 6, 7, 8, 9, and 10, were taken from, and comprise, Table 20, page 45, Monograph III. Data in column 2 were taken from Table 19, page 42, Monograph III. Data in column 4 were calculated by multiplying by 4 the figures in column 2 and subtracting the figures in column 3. Data in columns 11, 12 and 13 are the totals of those in columns 5 to 10, inclusive. Data in column 14 were taken from Table 19, page 42, Monograph III, and are obtainable by calculation from the data in columns 11 to 13, inclusive, above. Data in column 15 were obtained by dividing the figures in column 4 by those in column 2. Data in column 16 were calculated directly.

it. He did not ascertain whether *any* enamel defects, *undetected by his procedure*, became at each successive recorded age *gross enough for detection by these means*. He also failed to learn whether, at the other extreme, an approximately equal number of defects of Type 3 became so obviously carious that the teeth containing them were *excluded from the so-called "healthy" group*. This is a striking double omission from a plan for a supposedly unprejudiced study.

TABLE 2

Data in Table 1 for total average number of enamel defects of three types per "healthy" first molar, taken from Table 20 in Monograph III; arranged to show possible progression in the number of average defects from Type 1 to Type 3 in successive age-groups

Ages	6	7	8	7	8	9	8	9	10	9	10	11
Types	1	2	3	1	2	3	1	2	3	1	2	3
Average total number of enamel defects per "healthy" first molar	.22	.45	.66	.19	.35	.64	.24	.50	.85	.23	.51	.78

Ages	10	11	12	11	12	13	12	13	14	13	14	15
Types	1	2	3	1	2	3	1	2	3	1	2	3
Average total number of enamel defects per "healthy" first molar	.28	.48	.67	.28	.50	.64	.35	.39	?	.19	?	?

A comparison of the data in Monograph III for enamel defects, with the figures for "first molars, unhealthy (carious) or missing" (fourth column), and "first molars, unhealthy (carious) or missing, per child" (last two columns)—all assembled in our *Table 1*—should have suggested the *possibility* that the conditions in such a hypothetical progression were illustrated, in Table 20 in the Monograph, as *snap shots* for each age group rather than as *moving pictures*, and thus were shown in a static rather than a dynamic relationship. The following summary of data for three age groups, taken from our *Table 1*, facilitates this comparison:

AGE	NUMBER OF CHILDREN INVOLVED	FIRST MOLARS, UNHEALTHY (CARIOUS) OR MISSING NO.	AVERAGE TOTAL NUMBER OF EACH TYPE OF ENAMEL DEFECT PER "HEALTHY" FIRST MOLAR			FIRST MOLARS, UNHEALTHY (CARIOUS) OR MISSING, PER CHILD	
			Type 1	Type 2	Type 3	Average number	Per cent
6	76	66	0.22	0.41	0.76	0.87	21.7
9	121	120	0.23	0.50	0.64	0.99	24.8
12	138	233	0.35	0.50	0.67	1.69	42.2

That the author of Monograph III sensed the probability that there were enamel defects of the undetected, and therefore of the *uncounted*, kind in his work (which if recorded might have shown the progression suggested above), is indicated by these remarks intended by him to explain some difficulties in other connections: "The teeth that escape caries are more apt to be those that have remained healthy in spite of having observable enamel defect. The reason for this may very well be that the most dangerous types of enamel defect are those that cannot be observed until the groove is cut into with a burr (pages 41–42). . . . . First molars which seemed to our observers to have no enamel defects were more liable to caries than were those which could be described by them in terms of pit and fissure. (*Author's footnote:* This probably means that the enamel defects which are many times smaller than a tooth brush bristle escaped our examiners in spite of all possible vigilance"—page 48.)

In various parts of the Monograph the author indicates that the total number of children having "*four teeth* in the number six position" —first permanent molars—for ages ten, eleven, and twelve (pages 4 and 58) were respectively *1157* (pp. 6, 58, 116, 117), *1636* (pp. 4, 6, 26, 27, 58), and *1149* (pp. 6, 58, 118, 119), where the distributions of *non-carious* first molars were recorded as follows:

Age	*Upper right*	*Lower right*	*Upper left*	*Lower left*	*Total*
10	467	360	489	348	1,664
11	564	404	560	395	1,923
12	360	248	343	242	1,193

The following summary contrasts the foregoing totals with corresponding data as selected by the author for use in his Tables 18, 19, and 20, on the enamel defects in *non-carious* first molars (Table 20 is

discussed in the preceding comment under Quotation 8; Tables 18 and 19 will be considered in comment under succeeding Quotations):

AGE	DATA, IN VARIOUS PARTS OF THE MONOGRAPH, ON *non-carious* FIRST MOLARS		DATA, IN TABLES 18, 19, AND 20 OF THE MONOGRAPH, ON ENAMEL DEFECTS IN *non-carious* FIRST MOLARS	
	Total number of children	Total number of *non-carious* first molars	Total number of children	Total number of *non-carious* first molars
10	1,157	1,664	157	438
11	1,636	1,923	179	475
12	1,149	1,193	138	319
Total.....	3,942	4,780	474	1,232

Here we see that the data in Tables 18, 19, and 20 represent only a small portion of the corresponding data in the author's records. The Monograph fails to indicate why the author selected only about 12 percent of the children and only about 25 percent of the non-carious first molars to support his conclusions in Chapter IV regarding enamel defects and their relation to decay. The records of the defects in the non-carious first molars that were omitted from Tables 18, 19, and 20 are not given elsewhere in the Monograph. Therefore the alert reader can only speculate on the hidden reasons for these surprising omissions of most of the relevant data. Was this gross departure from the scientific method due to accident, or to carelessness; or did the excluded data prove something contrary to predetermined conclusions? Was it accident or carelessness which led the author to write, on page 41, that "Table 18 and Table 19 *show our observations?* (italic not in the original). These words naturally mean that *all* "observations" pertinent to the matter under discussion were *shown*. Did the author expect the reader to assume that only *a few* selected "observations" were *shown?* Was it accident or carelessness which led the author to write, on page 45, that "in presenting separately *the results* for each of the six types [of enamel defect]. . . . *such presentation is made* in Table 20?" (italic not in the original). This assurance obviously signifies that *all* "the results" in the author's records were *presented*. The facts in this paragraph of our comment do not support a belief that the Monograph is an accurate and sincere presentation.

Adverting to Quotation 8, we note, further, that half the number of enamel defects to which the author alludes (all of Type 3) were "considered as caries" (page 44), although accredited to teeth incorrectly called "healthy" and erroneously classified as "non-carious." We have already alluded to the fact that nothing was learned for any one group of children, examined recurrently *through a succession of ages*, regarding a progression or lack of progression of enamel defects of different sizes and kinds into a final state of caries. We see, therefore, that the irrelevant remark, in Quotation 8, about "organic immunity" is merely a mystic reference to nothing established in Monograph III.

Quotation 9. "*Table 18 shows that teeth entirely free from enamel defect by our examination occur less frequently among healthy teeth in children over ten years old than they do in the younger ones. The teeth that escape caries are more apt to be those that have remained healthy in spite of having observable enamel defect*" (*pages 41–42*).

The data in Table 18, for percentage of non-carious molars free from *detected* enamel defect, are arranged below to show graphically the falling and ascending sequences apparent in the figures:

Age	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Percent of non-carious first molars free from detected enamel defect	34	32	34	27	16	20	22	25

If the author's data here are reliable for the deductions he offers, they also indicate that the percentage of first molars free from *detected* defect decreased to a lowest value at age 10, but thereafter rose steadily to a new maximum. Whether this particular curve is significant, or merely an indication of error, variation, or coincidence, the author does not suggest. In *Table 1*, of the present report, we see that at age 11, for example,

The number of carious or missing first molars, in a total of 716 (4 x 179), was	241
The number free from enamel defects (Table 18—20 per cent of 475) was	95
The number remaining "healthy," but having enamel defects (475 −95), was	380
Total	716

According to the author, these 380 defective first molars, which had remained "healthy," were "*more apt*" to "*escape caries*" than the 95 first molars that were free from observable enamel defect. Yet these 380 "healthy" teeth had 370 (475 x 0.78) detected enamel defects of Type 3, which the author concedes "*may be considered as caries*" (page 44).

In a footnote on page 48 the author of Monograph III admits that "enamel defects which are many times smaller than a tooth brush bristle" probably were not detected "in spite of all possible vigilance." It may be fairly assumed that most of the defects that were not detected by his examiners, by the crude methods employed, existed in the teeth of the younger children, and that error in this relation became proportionately less at successive ages as the most minute defects became larger and more readily detectable. Possibly this condition accounts, in part at least, for the decrease in the recorded *proportion* of teeth without defect from age six to age ten.

In the next to the last paragraph in our discussions under Quotation 8, we called attention to the unreliability of the selected data in Tables 18, 19, and 20, in terms of the values for ages ten, eleven, and twelve, which are given in greatest detail in the Monograph and afforded the best basis for the comparisons noted in our comment. In the summary on page 522, we give the calculated distribution of first molars at the same three ages, per hundred of the maximum number based on data in Table 18 of the Monograph and *Table 1* of the present report, and thus show approximately the derivation of the teeth that became carious during the two years from ten to twelve.

If the author's data are accurate, the figures in column 6 suggest that the number of non-carious teeth that were *free from observable enamel defect* remained practically unchanged from age ten to age twelve. The figures in column 4 show that the number of non-carious teeth

AGE	CHILDREN	DISTRIBUTION OF PERMANENT FIRST MOLARS: PER HUNDRED OF POSSIBLE MAXIMUM NUMBER					
		Non-carious					Unhealthy (carious) or missing*
		Total	Defective		Free from defects		
yr.	no.	no.	no.	(%)	no.	(%)	no.
10	157	69.7	58.5	(84)	11.2	(16)	30.3
11	179	66.3	53.0	(80)	13.3	(20)	33.7
12	138	57.8	45.1	(78)	12.7	(22)	42.2
1	2	3	4	5	6	7	8

* On page 58 of the Monograph it is stated that "the average number of first molars extracted per child is .127, .176, and .305 for ages 10, 11 and 12, respectively," which, expressed in the same sequence as percentages, are 3.2, 4.4, and 7.6, indicating that the carious teeth for these three age groups were 27.1, 29.3, and 34.6 per cent in the above order.

having observable enamel defects decreased from 58.5 to 45.1 from age ten to age twelve—a difference of 13.4. The figures in column 8 show that the number of carious or missing first permanent molars increased from 30.3 at age ten to 42.2 at age twelve—a difference of 11.9, which is almost equal to the number of teeth that were lost meanwhile from the group of non-carious first molars having *observable enamel defects*. This general agreement between the decrease in the number of defective non-carious first molars, and the increase in the number of carious ones, seems to show that the "healthy" teeth *having observable enamel defects* were *not* "more apt" than the others to "*escape caries*," but instead more apt to *become carious*. If the author's data carry the import he ascribes to them, which we doubt, then he should not have ignored the fact that such examples as the foregoing indicate mathematically the direct opposite of his opinion as expressed in Quotation 9. (See comment under Quotation 10.)

There is nothing in Table 18, or in the Monograph, to justify the last statement in Quotation 9 for any age from six to thirteen, inclusive—the range of the recorded observations. The author appears to have considered only the probabilities favorable to his recorded conclusions. (See the next to the last paragraph in our comment under Quotation 8.) He indicates that, of the "healthy" first molars remaining in the relatively small number of children represented, the larger percentages "entirely free from enamel defect" were in the children under ten years of age. He did not make any observations

on a given group of children *recurrently during a succession of years*, and therefore did not ascertain whether enamel defects that existed in "healthy" first molars in the earlier years, but were not *detected*, became carious in later years. He did not exclude the *possibility* that enamel defects in first molars at ages from six to thirteen, inclusive, develop, or get large enough, in these teeth thereafter, to become detectable by the deficient means employed. His examinations could not indicate the age at which the observed enamel defects in the first molars of the older children were first detectable.

It is well known that in the older age-groups, the *proportions* of non-carious teeth having no observable enamel defect increase with age because most of the teeth having enamel defects become carious. These relationships are shown in the following summary of data available, for the age groups from fourteen to forty, before the beginning of the study described in Monograph III:

AGE	SURVIVING NON-CARIOUS FIRST MOLARS	
	With enamel defects	Without enamel defects
	percent	*percent*
6*	66*	34*
10*	84*	16*
13*	75*	25*
14–16	25	75
18–30	19	81
30–40	11	89

* From Table 18, Monograph III.

The exceptionally large proportion of non-carious first molars "free from enamel defect," as given in the author's Table 18 for selected children under ten years of age—*compared with those in the same record for ages eleven to thirteen, inclusive*—suggests that either a large number of actual defects there present were not detected but later became carious, or the data for the eleven, twelve, and thirteen age-groups are inaccurate. This summary also indicates that owing chiefly to lack of preventive measures, which are attainable in the main only in childhood, the mortality of non-carious first molars having enamel defects increases cumulatively with age.

Quotation 10. "*Table 19 shows that there is no decrease in average*

amount of observable enamel defect in the non-carious first molars of the older children. This leads us to the same conclusion [*as that stated in Quotation 9*], *namely. . . . a tooth without such defects as we are able to observe is just as likely to become carious as are the others. The effect of these findings on school health policy is of course obvious*" (*pages 42–43*).

In Quotation 9 the author stated: "The teeth that *escape caries* are *more apt* to be those that have remained healthy in spite of *having observable enamel defect*" (italic not in the original). In Quotation 10 the author said: "A tooth *without such defects* as we are able to observe is *just as likely* to *become carious* as are the others" (italic not in the original). On page 48, in the general conclusion at the end of Chapter IV, the author wrote: "First molars which seemed to our observers to have *no enamel defects* were *more liable to caries* than were those which could be described by them in terms of pit and fissure" (italic not in the original).

These assertions, taken separately as they occur, add plausibility to the author's discussions, especially for laymen, but which of these three contradictory assumptions is the inalert reader expected to accept? The age at which the enamel defects became "observable" in the *surviving* "non-carious first molars of the older children" was not determined. How soon the "healthy" first molars with observable enamel defects became carious, after they were examined, was not ascertained. There is no evidence that the author endeavored to learn which if any first molars that were *free* from observable enamel defect later *became carious*, nor the number that *remained* non-carious. His comment is essentially speculative.

Table 19, to which the author refers in Quotation 10, presents the "average number of pits and fissures per tooth," in the "non-carious" first molars of selected children at ages six to thirteen. (These figures are also given in column 14 of our *Table 1.*) But this "average number of pits and fissures per tooth" includes all the defects of Type 3, which the author stated on page 44, and again on page 45, "*may be considered as caries.*" On page 45, the author, seeing that this is an anomalous method of calculation, says it "modifies conclusions to be drawn from average amount of enamel defect by age as presented in Table 19"—but he does not indicate to the reader just what modifications of his conclusions should be noted. Below we compare the

totals of the figures (Table 19 of the Monograph) for "average number of pits and fissures per [non-carious] tooth" (all of Types 1, 2, and 3—the *latter being caries*), with the same values for Types 1 and 2 combined; also for each type separately (our *Table 1*):

Age	6	7	8	9	10	11	12	13
All types: 1, 2, and 3	1.39	1.32	1.24	1.36	*1.64*	1.54	1.52	1.23
Type 3	.76	.68	.66	.64	*.85*	.78	.67	.64
Types 1 and 2, combined	.63	.64	.59	.73	.79	.76	*.85*	.58
Type 2	.41	.45	.35	.50	*.51*	.48	.50	.39
Type 1	.22	.19	.24	.23	.28	.28	*.35*	.19

These figures, if they were as accurate as the author assumes, would suggest a *general* tendency of all types of defects *collectively*, in the first molars *that were called "healthy,"* to *increase* somewhat to a maximum at age ten, and to *diminish* thereafter to age thirteen; and a similar tendency for Types 1 and 2, combined and separately, to *increase* appreciably until age twelve, and then sharply to *decrease*. They do not indicate a state of *fixation*. But because they represent merely a small number of selected children, and not the same children at successive ages, they are probably expressive of coincidences rather than of anything significant. (See the next to the last paragraph in the comment under Quotation 8 on the bias and unreliability of the data in the author's Tables 18, 19, and 20.)

In our comment under Quotation 8, we alluded to the fact that the author seems to have assumed a *fixation* in the occurrence of *all* detectable enamel defects, and did not *exclude* the possibility of a *progressive* development of *some* defects—a progression in which *some* defects, by attaining the obviously-carious stage, would *eliminate the affected first molars from his record of the non-carious ones*. Besides, he did not present data showing that first molars having no observable enamel defect become carious, as a class, under any conditions. Therefore, the inference in the second sentence of Quotation 10 lacks the significance he gives it.

Quotation 11. "*It is obvious that carious teeth should not be considered in these observations of enamel defect, because the pits and fissures which have been involved in the caries cannot be known*" (*page 44*).

On the contrary it is *obvious* that the prevalent locations of caries

in carious teeth, and also of non-carious surfaces on carious teeth, should not have been disregarded. Why? Because caries in comparable adult teeth usually occurs in *similar locations*, which include all surfaces where enamel defects are present, and in the *same places* on these surfaces. A study of the common locations of caries would have suggested the possibilities of an operative preventive procedure. For example, pits and fissures do not occur on *every* surface of *every* tooth. Caries does not occur on *every* surface of *every* tooth. In examinations of 180,000 *lower incisal* teeth in 30,000 persons, under auspices other than those of Monograph III, not one pit or fissure, nor one carious cavity, could be found in the enamel of the *lingual* surfaces of these teeth. It is well known that, in *upper* first molars, enamel defects commonly occur in two of the five surfaces—the *occlusal* and *lingual*. In the *lower* first molars, the *occlusal* and *buccal* surfaces most frequently have enamel defects. Most dental authorities are agreed that in *adult* life the *increase* in caries is proximal; that is, on the mesial and distal surfaces. Therefore the degree of caries on these surfaces, in *adults*, should more closely approximate the incidence of caries in the pit-and-fissure surfaces. In examinations of 12,753 male and female persons, at various ages over 16, it was found, before the research described in Monograph III had been started, that, in the two surfaces of the upper and lower first molars which frequently have enamel defects, there were 38,388 carious cavities, but only 8,021 in the other three surfaces. These figures, divided by the number of surfaces represented, indicate that there were 19,194 carious cavities for each *pit-and-fissure* surface, and only 2,674 for each *smooth* surface—a ratio of over 7 to 1.

In the formulation of a public dental-health policy, is it not obviously very important to know upon which surfaces of the teeth preventive procedures may be successfully applied? Such a policy must give consideration to the exact locations in which decay *commonly* occurs, and to the reasons why these surfaces more than others are likely to become carious. Decay in pits and fissures *may not be discernible at the surface.* Its progress underneath the surface is often so slow that, to a casual observer, there may be no *visible* difference between the condition at the surface today and a year ago. The most conclusive proof of the special liability of pits and fissures is found in the data for

caries secured after age thirteen. Therefore, the time to prevent pit-and-fissure decay is before that age. (See comment also under Quotation 12.)

In *Table 1* of the present report we indicate, from data in Monograph III, some calculated values that the author seemed to ignore, including the total number, and the average per child, of "first molars, unhealthy (carious) or missing." To facilitate comparisons, some of these data, and added figures for percentages, with data for ages 20–24, 25–29, and 30–34 from other sources, in extension of the foregoing comment, are summarized in *Table 3*, on page 528.

Quotation 12. "*If all pits and fissures are to be filled, then there is necessary the ability to find them all in a manner which is applicable to organized administration. And it is particularly necessary to be able to find those that are most liable to decay. If these distinctions cannot be made, then either all grooves at the point of enamel lobe coalescence on the occlusal surfaces of first molars must be filled or the practice must be abandoned, and, instead, recommendations made that recognizable caries should be filled promptly on their* [*sic*] *appearance*" (*page 40*).

In the general application of preventive measures, mortality is a decisive factor. When the mortality is high, it is desirable to apply a preventive procedure to all, regardless of the probable immunity of some. The same principle applies to prevention of loss of first molars, especially because of their outstanding importance in mouth health, and in the normal development of the jaws and head. In a group of 1000 males and 1000 females, between ages sixteen and thirty, the following dental mortalities (extractions) were noted before the publication of Monograph III: upper right first molars, 29 percent; upper left molars, 28 percent; lower right molars, 47.6 percent; lower left molars, 51.6 percent.

In the comment under Quotation 11 it was shown that the ratio of caries in *pit-and-fissure* surfaces to caries in *smooth* surfaces is more than 7 to 1. In an examination of 251 *buccal* surfaces of *lower* first molars, before the beginning of the research described in Monograph III, special attention was given to the places where caries is not frequently found, and also where caries often occurs. The convexity of the *buccal* surfaces of lower first molars is divided by a shallow groove that frequently has an enamel defect. It appeared probable that,

TABLE 3

Data relating to total number of unhealthy (carious) or missing first permanent molars, and average per person, at ages 6 to 34; taken from Monograph III and other sources

Age[1]	6	7	8	9	10	11	12	13	20–24	25–29	30–34
Number of persons examined	76	117	116	121	157	179	138	74	4,427	1,301	757
Number of *healthy* first molars involved	238	371	354	364	438	475	319	173	951	265	118
First molars, *unhealthy* (carious) or missing.											
1. Total number	66	97	110	120	190	241	233	123	16,757[2]	4,939[2]	2,910[2]
2. Average per person	0.87	0.83	0.95	0.99	1.21	1.35	1.69	1.66	3.77	3.78	3.84
3. Percentage of normal number	21.7	20.7	23.7	24.8	30.3	33.7	42.2	41.6	94.2	94.7	96.0
a. Difference, compared with preceding age	..	(−1.0)	3.0	1.1	5.5	3.4	8.5	(−0.6)	..	0.5	1.3
b. Cumulative difference	..	(−1.0)	2.0	3.1	8.6	12.0	20.5	19.9	..	0.5	1.8

[1] Data for ages 6 to 13, inclusive, are taken from Monograph III, or calculated therefrom. (See *Table 1* of the present report.)

[2] Includes "missing and defective."

because of the frequency of defects at this specific location, this defective groove is apt to become carious, whereas the smooth convex surfaces, owing to their shape and structure, are not likely to decay. In these 251 lower first molars, there were 235 carious cavities in *grooves*, but only 8 in each of the two *smooth* portions of the buccal surfaces. In a group of 12,753 persons of all ages and both sexes, and from all walks of life, the *buccal* surfaces of *lower* first molars were found to be twelve times more frequently decayed than the buccal surfaces of *upper* first molars. Why? This difference is due to faulty coalescence of enamel rods in a specific location on *lower* first molars, which rarely occurs in the *buccal* surfaces of *upper* first molars; it explains the lower vertical correlation of decay in first molars. These conditions are present also in the *lingual* surfaces of *upper* first molars, with the result that these upper surfaces are fourteen times more frequently decayed than the lower ones. Similar information has long been available regarding the 32 surfaces in which pits and fissures are more frequently found than in the other 128 surfaces. Thus the 32 *pit-and-fissure* surfaces are six times more frequently decayed than the 128 smooth surfaces. The *occlusal* surfaces of the four first molars decay eleven times more frequently than their smooth distal surfaces, and five times more frequently than their smooth *mesial* surfaces. Therefore, it is not difficult to decide which surfaces, and which specific locations on these surfaces, are likely to become carious.

The proof that enamel defects, such as pits and fissures, increase the liability to decay is found in adults. Some years ago, in an examination of 1,233 molars and bicuspids having no fillings and no visible evidence of caries, it was found that 18.9 percent had pits and fissures, and 81.1 percent had no pit or fissure. These teeth were not in a selected group, but in persons between ages 30 and 40, and representing a cross-section of society as found in all walks of life. Available data on *over four million surfaces* of teeth enable dentists to tell which surfaces are most likely to become carious and which are least likely to undergo decay. A public dental-health policy should be based on the facts pertaining to all of the teeth and to all of their surfaces. In this respect Monograph III is seriously inadequate, for it was restricted in its analysis of the import of enamel defects, not only to single examinations of a few children and teeth, but also to one-fifth of the surfaces of one type of tooth.

Quotation 13. ***"The spread of caries is not due to any localized cause but to some influence common to all parts of the mouth"*** (*page 19*).

In this statement the author seems again to have disregarded the findings of modern dental research, which indicate that although the surfaces of all the teeth are subject in common to destructive influences, *local conditions* decisively aid, or make it possible for, these *influences* to *cause* decay. Having omitted four of the five tooth-surfaces, in considering enamel defects and thus conducting an inadequate study, the author concluded that caries is *not* due to any *local* factor. Such an unwarranted deduction could not have been made if the five tooth-surfaces had been included in his analysis, and careful attention given to the similarity in the surface-form of the loci of prevalent decay, or to the usual surface-position of decay, in each type of tooth. In studying caries in pairs of upper or lower molars, it is very significant that the greater degree of decay is always in similar localities on the teeth—also, that the surfaces that are usually *free from* caries are always in similar locations. (See also comment under Quotation 14.)

The following comment from another source, on more fundamental and significant conditions than any mentioned in Monograph III, has an important bearing on the question whether decay may be brought about by local factors in the enamel:

"The incidence of decay when present in these twins is a matter of some interest since the distribution of decay beginning on smooth surfaces was quite haphazard. On the other hand, decay commencing in the pits and fissures was rather uniform. In fact, the working of the asymmetry mechanism could be frequently traced in the pits and fissures, as a number of identical twins had decay in corresponding teeth. Since the majority of these pits and fissures eventually decay, it is concluded that heredity affects dental decay only inasmuch as it controls the gross morphology of a tooth, its pits and fissures, and its position in the dental arch."[5]

Quotation 14. ***"Were caries the product of accidental combinations of***

[5] A study of teeth and dental arches of identical twins: Samuel Goldberg, D.D.S., M.S.D., L.D.S. Thesis presented in partial fulfillment of the requirements for the degree of Master of Science in Dentistry, at Northwestern University, June 18, 1928. In an abstract of some of the work described in this dissertation, Dr. Goldberg wrote that the results suggest "that the heredity mechanism, by determining the position of pits and fissures, may affect the *location of caries*." *Journal of Dental Research*, 1929, ix, p. 274.

circumstances then there would be no real correlation between decay in any given tooth and the decay in another. Then we would have obtained a chance distribution of r's with zero as their average. Since all correlations are positive we must assume that either the caries in one tooth affect [*sic*] *the caries in another, or that caries are* [*sic*] *in part a common result of some influence which operates on both teeth. We have noted in Chapter 1 that these positive correlations vary in size. This means that the influence that teeth have upon each other, or the degree to which teeth share some common influence, varies with the type and position of the teeth concerned*" (*page 13*).

In this use of the word "influence," the author disregards the unequal effects of local *conditions* in facilitating or failing to support the local incidence of caries. To say, with the author, that "the degree to which teeth share some common influence *varies with the type and position of the teeth concerned*," is one way of asserting that the places where there are observable actions of a common *influence* in the mouth are determined by local *conditions* of or on the teeth. "Type of tooth" includes, in its obvious meaning, local kinds and variations of surface *conformation*, and also local kinds and variations of enamel *structure*. These are widely dissimilar in their reception or rejection of the destructive agencies that bring about caries, which is a *local disorder* or, owing to unequal conditions, a variable *local manifestation* of the operation of a *general* influence. Conformation and structure of enamel surfaces, not only as to position in the mouth but also on any tooth, are *local* determining factors in the development of carious cavities. The biological reasons for variations in these conditions of the enamel are, for the most part, unknown. (See also comment under Quotation 15.)

The author decides, from mathematical calculations alone, that "accidental combinations of circumstances" cannot be factors in any decay. He does not seem to have learned in his examinations, however, whether mechanical injury, destructive tooth-cleaning fluids, medicines, etc., affected the data, or whether systemic diseases, inadquate diets, etc., were "accidental combinations of circumstances" that determined the incidence and the situation of local defects (caries) in the enamel of some, perhaps a large proportion, of the teeth examined.

Studies of the teeth of adults have indicated the surfaces, and the specific locations on each surface, where dental decay commonly occurs early in life. These data suggest the nature, extent, and applicability of a practical preventive procedure. The time for its protective application is obviously in very young children before decay can start. Monograph III has not shown that these current views in dentistry are unfounded. It has not contributed any new facts or ideas to the knowledge of the cause or control of caries.

Quotation 15. "*Decay is periodic and. . . . a function* [*"peculiarity"*] *of the individual organism and not the tooth*" (*pages 19–20*). "*Decay of teeth happens to mouths in a periodic manner. It follows that the carious condition of certain teeth is a measure of the influences which cause decay only for those periods during which they have been in the mouth*" (*page 57*).

On page 17 the author wrote: "Teeth share common decay influences because they are in the mouth at the same time and *not because they are part of the same organism*" (italic not in the original). This is another significant contradiction.

The conclusions in Quotation 15 are the author's *answer* to two questions, which, raised on page 1, are referred to there as important: "1. Is the liability to dental caries a product of inherited and very early environmental factors which operate upon the organism with equal strength throughout its lifetime, *or does this liability to dental decay occur in some periodic manner?* (italic not in the original). 2. Is liability to caries a function of the tooth or of the organism?" (*Author's footnote:* "In other words, 'Is liability to caries a *peculiarity* of the tooth or of *the organism*' "? (italic not in the original).

The views in Quotation 15, on the relation of heredity, prenatal conditions, etc., were derived mathematically from examinations of only a small number of "children who had four teeth in the number six position [first permanent molars] and four teeth in the number five position [deciduous second molars or second bicuspids]. Children having unerupted or extracted teeth were excluded" (page 4). The chief *reason* for the conclusions in Quotation 15 is stated thus (page 20): "Horizontal relations of caries are higher than either vertical or diagonal ones, and so correspond with similarities in time of eruption and with general organic bisymmetry." This explanation was dis-

cussed in the comment under Quotation 7, where its incompleteness was indicated, and where variations in the conformation and structure of the enamel surfaces as *functions* (*peculiarities*) *of the tooth* were emphasized.

On page 39 the author states the obvious as follows: "The chances for further development of caries in any one tooth are smaller when previous decay in that tooth has been corrected." But if decay is not dependent upon *local* factors (Quotations 13 and 14), and is "a function [peculiarity] of the individual organism and not the tooth," how can this be true? Possibly the author would wish us to rely upon this brilliant comment on page 29 of the Monograph: "Some common factor exists in mouths *at certain times* which exposes all of the teeth present to likelihood of decay. *Such waves of influence could conceivably be checked by filling the cavities*" (italic not in the original). Just why these "waves of influence" touch only spots here and there on a tooth, and do not affect *all its surfaces impartially and equally*, the author does not suggest, although he serenely surmises that the destructive *general* influence may be "checked" by repairing the *local* damage it is doing! Perhaps he would also check small-pox by merely treating the skin lesions it causes. But scientific skepticism, and clinical observations and experience, must yield to mathematical intuition, whereupon it becomes obvious that since "decay is. . . . a function [peculiarity] of the individual organism and not the tooth," then the act of "*filling the cavities*" so completely and mathematically frustrates the "waves of influence" that they immediately cease to wave. Naturally, it would be absurd in a dentist to believe that, when decay is "checked by filling the cavities," *local* dental *conditions* that facilitated the onset of decay are thereby removed, and the *occasion* for decay eliminated. Higher mathematics would not support him! And of course it would be equally non-mathematical for a dentist to conclude that when *filling a cavity* saves the *rest of an affected tooth*, while "*a wave of influence*" *is waving*, this saving occurs because a very liable surface has thus been removed; because destructive action of the ubiquitous and abiding "influence," under the adjacent surfaces, has been stopped and mechanically excluded; and because the *remaining* surfaces on the tooth are less, perhaps not, likely to become carious since the *local conditions* are not favorable.

C. General remarks

The title of the Monograph, "Public health aspects of dental decay in children," is inappropriate and misleading. This subject is ignored not discussed.

According to the Foreword, the Monograph "arose out of the growing realization, particularly among educators, that the accumulation of definite evidence of cause and effect relationships was essential to the progress of the school health program" (page vii). The Monograph has failed to contribute anything to this desired evidence. The author suggests that his findings and assumptions will have an "obvious effect" on "school health policy." We feel that they should have no effect on the administrators of such policies other than to create desire for an explanation of the reasons why the research described by the author, and sponsored by a national association for the betterment of child health, was not conducted more thoroughly and reliably.

The chief conclusions in the Monograph are either restatements of well known facts, or erroneous deductions from insufficient or irrelevant data. They are based on single examinations of a comparatively small number of children and teeth. Attainment of the purpose set forth in the Foreword required either a study of a very large number of children and teeth in the manner described, or the *recurrent examination of a given group of children through a succession of years.*

The author bases much of his discussion and stated opinion upon the erroneous assumption that current dental-health programs in public schools are intended primarily to prevent dental decay, whereas thus far practically all of them have been projected to achieve mouth cleanliness and to promote general health, both of which objectives have undoubtedly been advanced. Mass procedure in operative preventive work in public dental-health programs has hardly been begun.

Monograph III is unscientific because it does not describe essentials in some of the basic procedures, omits important relevant data, disregards established facts and conditions, and is not impartial. Its mathematical dress-up will induce many to regard it, on that account, as particularly accurate and reliable.

The Monograph is sponsored as an authoritative declaration on an

important question of public dental-health policy. It should not have been issued on its present narrow basis and with its restricted understanding of the realities of dental service. These serious limitations give the Monograph the appearance of a prejudiced publication.

The author repeatedly indicates in a general way that in attempting, in a negative sense, to guide public-health administrators, he intended to present not a constructive program for the most effective conservation of child health, but instead merely an inferior substitute, which is assumed to be *practical*, apparently because it is based indifferently on presumptions of deficient financial support, and of mediocre professional service.

Results beneficial to the health and well-being of school children, improvement in their deportment, and reduction of retardation in their school progress with less waste of the taxpayer's financial contribution to public welfare, as assured consequences of an effective oral-health policy in schools, have apparently not interested the American Child Health Association. The Monograph totally ignores these well established facts, although there are thousands of authentic instances of such results of dental health-service for children in public schools. Yet the American Child Health Association has the temerity to present Monograph III as an authoritative publication on "Public *health* aspects of dental decay in children." Would not a more appropriate title have been: "A mathematical obfuscation of some well known facts relating to dentistry for children?"

D. Recommendation (as to procedure)

In concluding this general report, we recommend that (a) a thorough study of Monograph III be undertaken by the Oral Hygiene Committee of Greater New York, with the cooperation of leading dental organizations and other advisers; and that, at the conclusion of the study, (b) the merits of the Monograph be set forth, and (c) its deficiencies, unwarranted deductions, and misleading statements be promptly noted and corrected—for the information of the general public, administrators of public-health programs, dentists, physicians, and all others concerned in the development of public agencies for the protection of child health.

E. Appendix indicating changes in the condition of the first permanent molars in some school children as noted thirteen months after their examination for the record in Monograph III[6]

Since the presentation of the foregoing report, the Sub-committee, having studied some comparative data bearing on the validity of conclusions in Monograph III, has reaffirmed and extended its statement of convictions as expressed in the original report.

One of the dentists who had been invited to supervise the *training* of the dental hygienists in the technical procedure of the study described in Monograph III happened to be a member of the Oral Hygiene Committee, and was familiar with general conditions of the study at Public School No. 11 in New York City. A year later, wishing to repeat the examinations by the same procedure, he requested the author of Monograph III to present, and from him received, the names of, and corresponding data recorded for, the children at this school whose dental conditions had been included in the records on which the Monograph is based. The re-examinations, conducted thirteen months later, were made as closely identical with those of the original examinations as possible by the use of a similar technique under analogous conditions. Results of the first examination and of the re-examination are directly contrasted in detail in *Table 4*, on pages 538 to 541 inclusive.

Table 4 indicates, in a very striking manner, that such a study as that recorded in Monograph III cannot give a true insight into dental conditions in particular age-groups unless it deals with a very large number of children in each such group, or with the same groups of children examined recurrently through a succession of years. One sees, at a glance, that a very large number of pits and fissures that were present at the first examination became carious cavities at the second; pits and fissures, which had not been observed at the first examination, became "observable" at the second; decay spread, fillings multiplied, and "O K" molars diminished; and the number of missing first molars was much greater. Case 37, cited here as an illustration, suggests a high degree of liability to caries during the

[6] Presented, at a special meeting of the Oral Hygiene Committee of Greater New York, on August 4, 1930, by the Sub-committee named in footnote 4.

intervening year. At the first examination (age thirteen) two molars were recorded as "O K;" two, *non-carious*, had pits and fissures. Yet, only thirteen months afterward, one "O K" molar had been extracted, another "O K" molar had a filling and a fissure; and the two molars that originally had pits and fissures, but were non-carious, acquired two cavities each. If, in this child, immediate attention had been given, after the first examination, to the dental surfaces *where decay usually occurs*, all of these serious developments would probably have been prevented. A close examination of *Table 4* reveals tragic consequences of the *do-nothing* policy approved in Monograph III.

Some numerical data of special interest, obtained from *Table 4*, are shown in the appended summaries (A-E):

Summary A

	Teeth	
	Number	*Percent*
"O K" first permanent molars (non-carious and free from enamel defects)—in a total of 44—that became carious, or were extracted after the first examination, and *before* the *second* examination[7]	21	47.7
Non-carious first permanent molars (71) *having* observable pits or fissures at the first examination: at the *second* examination[8] there were		
(a) Carious cavities in	63	88.7
(b) No carious cavities in	7	9.9
(c) Extracted	1	1.4
(d) (Ten additional first permanent molars having observable enamel defects at the first examination were recorded as "OK" at the second.)		

[7] Whether these teeth contained enamel defects that were overlooked at the first examination and became carious before the second, cannot be determined, but, in 8 "O K" molars that remained non-carious, 14 pits and fissures were noted at the second examination.

[8] For molars *having* pits or fissures, the ratio of teeth that became carious to those that did not was approximately 9 to 1. For molars having *no* pit or fissure, the ratio of teeth that became carious to those that did not was approximately 1 to 1. Thus, the surfaces of the first permanent molars *having* pits or fissures were *nine times* more apt to decay than those having no pit or fissure.

TABLE 4

Comparative data, at two examinations, on the same children in Public School No. 11, New York City[1]

Symbols: A, filling. *b*, buccal. *BD*, badly decayed. *C*, carious cavity. (*cp*), compound, including occlusal. *d*, distal. *F*, pit or fissure (pre-carious). *l*, lingual. *m*, mesial. *o*, occlusal. *O K*, no defect, no caries. *R*, root. (*rec*), caries at filling ("recurrent"). *X*, extracted. These symbols are united in others of obvious import such as *Fo* = occlusal pit or fissure (pre-carious). Where no surface is indicated, *occlusal* is meant.

Age-groups at the first examination: *ten*—case 53; *eleven*—cases 54–77; *twelve*—cases 1–26; *thirteen*—cases 27–52. At the second examination each group was one year (thirteen months) older.

	FIRST EXAMINATION: MARCH, 1929; FOR THE AMERICAN CHILD HEALTH ASSOCIATION				SECOND EXAMINATION: APRIL, 1930; INDEPENDENTLY, FOR DIRECT COMPARISON			
Case number	Tooth number							
	UR-6	UL-6	LR-6	LL-6	UR-6	UL-6	LR-6	LL-6
1	1 C	R	1 C	R	1 C (large)	R	1 C (large)	R
2	R	2 F	3 F	R	R	1 F	2 F, 1 C	R
3	OK	1 F, 1 C	X	1 F, 1 C	1 C	2 C	X	X
4	2 A	1 A, 1 C	1 A	1 A	2 A	1 A, 1 C (cp)	1 A	1 A
5	1 Fl, 1 Fo	2 A	1 A	X	2 Co, 1 C (cp)	1 A, 1 Cl	1 A	X
6	OK	OK	OK	OK	OK	OK	OK	1 C
7*	R	R	X	R	2 A	2 A	X	1 A, 1 C (cp)
8	2 A	1 F, 1 A	OK	OK	2 A	1 A, 1 C	1 Cd	1 C
9	2 Fo, 1 Fl	3 Fo, 1 Fl	2 Fo, 1 Fb	1 F, 1 C (cp)	2 Co, 1 Cl	2 Co, 1 Cl	2 Co, 1 Cb	BD
10	OK	OK	OK	1 F	2 F	2 F	1 C	X
11	OK	X	1 C	X	OK	X	1 C (large)	X
12	2 F	3 F	R	X	2 C, 1 Fl	2 Co, 1 Cl	X	X
13*	2 F, 1 A (cp)	X	X	1 A	2 C, 1 Am	X	X	1 A
14	OK	OK	1 A	OK	1 C	1 F	1 C	OK
15	2 A	1 A	2 F	1 A	1 A (large)	1 A	1 C	1 C
16	2 F, 1 C	1 C	X	X	BD	BD	X	X

17	X	R	R	X	X	R	R	X
18	X	X	X	X	X	X	X	X
19*	OK	2 F	1 F	X	2 C	OK	OK	X
20	2 A	2 A	X	X	2 A, 1 Cl	2 A, 1 Fl	X	X
21	1 F	R	X	X	1 C	X	X	X
22	1 A	1 A (rec)	1 F, 1 A	1 A, 1 F	1 A, 1 C	2 A	1 A, 1 C	1 A
23	OK	2 A	1 A	1 A, 1 F	1 Fl	2 A, 1 Fl	1 A	1 A, 1 Co, 1 Cb
24	R	1 C	R	OK	R	X	R	X
25	2 Fo, 1 Fl	2 F	R	4 Fo, 1 Fb	2 C, 1 Fl	1 C (large)	R	BD
26	1 Fo, 1 Fl	1 Fo, 1 Fl, 1 C	X	X	2 Co, 1 Cl, 1 Cb	3 C, 1 Fl	X	X
27	2 F	2 F	1 F	Crown	1 C (cp)	2 C	1 C	Crown off
28*	1 A (cp)	1 A (cp)	1 A	1 A, 1 Fo, 1 Fb	1 A	1 A	1 A	1 A (large)
29	1 F	OK	1 F	OK	1 F	OK	1 C	1 Co, 1 Cm, 1 Fb
30	OK	2 F	1 C (cp)	1 F	1 C	2 C	BD	1 C (large), 1 Fb
31	2 A, 1 Fl	X	X	1 F, 1 Ao, 1 Ab	2 A, 1 Cl	X	X	2 Ao, 1 Ab
32*	R	R	R	R	X	X	R	1 C (large)
33	OK	1 F	1 F	X	3 Fo, 1 Fl	2 Co, 1 Cl	1 C	X

[1] Owing to ordinary conditions affecting continuance in the school, the number of the original children available at the second examination had been considerably reduced. The records of only the children that could be reexamined are included in this table.

On page 4 of Monograph III it is stated: "We have included in these data only children who had four teeth in the number six position [first permanent molars] and four teeth in the number five position [second bicuspids or deciduous second molars]. Children having unerupted or extracted teeth were excluded." The data in this table indicate the inclusion of thirty-nine children from whom one or more first permanent molars had been extracted, or were represented only by roots. Possibly by the words "included in these data," in the foregoing quotation, the author meant data *as published* in the Monograph, not as recorded by the examiners.

In the first paragraph of the Foreword of the Monograph, it is stated that the data were obtained "during the school year 1927–28," and that "supplementary data were also obtained from other groups of children." The data of the first examination in this table were evidently among the supplementary findings.

* Inconsistencies, owing to errors of observation or record, may be noted among the data for cases 7, 13, 19, 28, 32, 36, 45, 47, 48, 49, 52, 58, 61, 62, 65, 74, 77. There is no reason to believe that the second examination was conducted less carefully or accurately than the first examination.

TABLE 4—*Concluded*

	FIRST EXAMINATION: MARCH, 1929; FOR THE AMERICAN CHILD HEALTH ASSOCIATION				SECOND EXAMINATION: APRIL, 1930; INDEPENDENTLY, FOR DIRECT COMPARISON			
Case number	Tooth number							
	UR-6	UL-6	LR-6	LL-6	UR-6	UL-6	LR-6	LL-6
34	2 F	2 F	R	1 F, 1 C	1 Co, 1 C (cp)	2 Co, 1 Cl	BD	1 C (cp, large)
35	1 C	OK	1 Fo, 1 Fb, 1 C	1 F	1 C	OK	1 C (large)	1 C
36*	OK	1 F	1 F	1 F	OK	2 C	2 C	OK
37	OK	2 F	1 F	OK	X	2 C	1 Co, 1 Cb	1 A, 1 Fb
38	R	3 F	R	R	R	1 C	R	R
39	1 F	2 F	2 F	OK	1 C	2 C	1 C	1 C
40	1 F	OK	1 C (cp)	1 F, 1 A	2 F	1 C	BD	1 A, 1 C
41	R	4 F	X	X	X	1 Co (large), 1 Cl	X	X
42	1 A (rec)	OK	X	1 A (rec)	BD	OK	X	BD
43	OK	1 C (cp)	X	X	OK	1 F, 1 A (cp, large)	X	X
44	1 F	2 C	R	1 F, 1 Cm	2 C	2 C	R	1 Co, 2 Cb, 1 Cm
45*	OK	1 F	OK	OK	1 Cm	OK	2 Co, 1 Cb	1 C
46	1 F	1 C, 1 F	R	R	2 F	2 C	X	R
47*	1 F, 1 A	1 F, 1 A (cp)	1 A	1 A	1 C (cp), 1 A	OK	OK	1 A (rec)
48*	1 Cm	2 C (cp)	X	1 Co, 1 C (cp)	1 C (cp)	2 C (cp)	X	1 C
49*	2 F	1 F, 1 C	1 C (cp)	X	1 C	1 A	1 A	X
50	R	R	R	R	R	R	R	R
51	1 A (rec)	1 A (cp)	1 A, 1 Fb	2 C	1 A (cp), 1 C (cp)	1 A (cp)	1 A (cp), 1 Co, 1 Cb	2 C (cp, large)
52*	R	X	R	R	OK	X	X	R
53	1 C, 1 F	OK	3 F	1 C, 1 F	2 C	OK	1 C (large)	X

54	1 F	2 F	X	4 Fo, 1 Fb	1 Co, 1 Cl	1 Co, 1 Cl	X	2 Co, 2 Cb
55	1 A	3 F	1 C	1 A	1 A, 2 C	1 C	BD	1 A, 1 C
56	X	1 F	OK	2 F, 1 C	X	1 C	1 F	BD
57	2 A	2 A	1 Ao, 1 Ab	1 A	BD	2 A, 1 F, 1 Cl	1 Ao, 1 Ab	1 A, 1 Cb
58*	2 F	2 Fo, 2 Fl	1 C	1 C	1 C	OK	1 A	1 A
59	1 Fo, 1 Fl, 1 C	X	X	X	X	X	X	X
60	OK	OK	1 Fo, 1 Fb	2 Fo, 1 Fb	1 F	2 F	1 Co, 1 Cb	1 Co, 1 Cb
61*	2 F	2 F	2 F	3 Fo, 1 Fb	1 C	OK	1 C (large)	1 Co (large), 1 Cb
62*	1 F	1 F	1 Ab, 1 F	1 A, 1 Cb	OK	2 C	1 Ab	1 Ao, 1 Ab, 1 Cb
63	R	R	R	1 A	R	R	R	1 A, 1 C
64	2 Ao, 1 Al	3 A	1 Ao, 1 Ab	1 Ao, 1 Ab	1 Ao (large), 1 Al	1 Ao (large), 1 Al	1 Ao, 1 Ab	1 Ao, 1 Ab
65*	3 F	1 F	2 A	2 A	OK	OK	2 A	2 A
66	2 F, 1 C	OK	1 A, 1 F	X	1 C (large)	OK	1 Co, 1 Cb, 1 A	X
67	X	2 F	1 Fo, 1 Fb	3 Fo, 1 Fb	X	1 F	1 Co, 1 Cb	1 Cb (large), 3 Co
68	2 F	1 Fo, 1 Fl, 1 C	1 F, 1 Co, 1 C (cp)	X	2 C	2 C	BD	X
69	OK	1 F	2 F	1 F, 1 A	OK	1 C	1 C	1 A
70	OK	1 Cm	1 A	1 A	2 A, 1 C	1 C (cp, large)	2 A, 1 C	1 A, 1 Cb
71	OK	1 F	3 F	OK	OK	1 C	1 Co, 1 Cb	1 C
72	1 F, 2 A	1 Fl, 2 A	1 F, 1 Ao, 1 Ab	1 F, 1 Ab	2 A	2 A	1 Ab, 1 F, 1 C	1 Ab, 1 F
73	1 F	OK	2 F	R	2 C	1 C	BD	R
74*	1 F	1 F	2 F	3 F	1 C, 1 F	2 Fb	1 Co, 1 Cb	2 Co, 1 Cb
75	3 F	3 F	1 C, 1 F	5 Fo, 1 Fb	1 Co, 1 Cb	2 C	1 Co, 1 Cb	1 Co (large), 1 Cb
76	1 A (rec)	1 A (rec)	1 A	1 A (rec)	BD	1 A (rec)	1 A (rec)	1 A (rec)
77*	1 F	OK	OK	1 Fo, 1 Fb	OK	OK	1 C	2 F

* Inconsistencies, owing to errors of observation or record, may be noted among the data for cases 7, 13, 19, 28, 32, 36, 45, 47, 48, 49, 52, 58, 61, 62, 65, 74, 77. There is no reason to believe that the second examination was conducted less carefully or accurately than the first examination.

Summary A—continued

	Teeth	
	Number	*Per cent*
Non-carious first permanent molars (44) having *no* observable pit or fissure at the first examination: at the *second* examination[8] there were		
(a) Carious cavities or fillings in	19	43.2
(b) No carious cavities in	15	34.1
(c) Pits and fissures in	8	18.2
(d) Extracted	2	4.5
	Pits and fissures	
Pits and fissures in 64 non-carious teeth as recorded at the first examination that were found to be carious cavities at, or were present in teeth extracted *before*, the *second* examination	136	....
Pits and fissures not observed at the first examination, but recorded at the *second* examination in 11 non-carious teeth	18[9]	....

On page 41 of the Monograph the author asks: "Is it a fact that non-carious teeth of older children have a greater proportion free from all observable pits and fissures?" He adds: "Table 18 would indicate that they do not." On page 519 of the present report it is shown that these conclusions in Monograph III rest upon merely a few selected data. The comparable data in the accompanying summaries (*B* and *C*), prepared from our *Table 4*, do not agree with those selected for use in Table 18 of the Monograph.

On page 42 of the Monograph, the selected data in Table 19 seem to indicate that "there is no decrease in average amount of observable enamel defect in the non-carious first molars of the older children." The author of the Monograph then concluded (p. 43) that "a tooth without such defects as we are able to observe is just as likely to become carious as are the others," and that "the effect of these findings

[9] Case 60 (age eleven), in *Table 4*, illustrates both progression in the size of pre-carious pits and fissures (as classified in the Monograph), and the tendency of pits and fissures to become cavities: two "OK" upper molars at the first examination had three occlusal defects at the second; two non-carious lower molars, having three occlusal and two buccal pre-carious defects at the first examination, acquired two occlusal cavities and two buccal cavities before the second.

on school health policy is of course obvious." On page 519 of the present report it has been shown that these conclusions in Monograph III rest upon incomplete and selected results. The data of the first examination, given in *Summaries D* and *E* from the record in our *Table 4*, could not have been selected by the author of the Monograph

Summary B

*Non-carious non-corrected first permanent molars: number having no occlusal enamel defect**

CASE RANGE IN TABLE 4	FIRST EXAMINATION				SECOND EXAMINATION			
	Age	Number of teeth involved	Number of teeth free from defect		Age	Number of teeth involved	Number of teeth free from defect	
			Total	Percent			Total	Percent
54–77	11	34	8	23.5	12	12	9	75.0
1–26	12	18	13	72.2	13	5	4	80.0
27–52	13	30	12	40.0	14	9	7	77.7

Summary C

*Data for age groups in Summary B; for results of both examinations combined**

AGE	NUMBER OF TEETH INVOLVED	NUMBER OF TEETH FREE FROM DEFECT		PERCENT FREE FROM DEFECT, AS RECORDED FOR AGE GROUPS IN TABLE 18, MONOGRAPH III
		Total	Percent	
11	34	8	23.5	20
12	30	22	73.3	22
13	35	16	45.7	25
14	9	7	77.7	..

* Only children having all first permanent molars in place are included in this calculation. There was only one child at an age less than eleven in this school group (Case 53).

to illustrate his views, for his preconception would not have been supported by them.

The data in *Summaries A–E*, derived from *Table 4* in this report, are presented to suggest not that they are more accurate or reliable than those in Monograph III, but, on the contrary, that they are equally non-significant for identical reasons. The data in these summaries and also in Monograph III are very deficient in scope and

recurrence. In each group the number of children (teeth) was too small to be representative, and the same groups of children (teeth) were not examined recurrently during a *succession of several years.*

Summary D

*Non-carious non-corrected first permanent molars; number of occlusal pits and fissures**

CASE RANGE IN TABLE 4	FIRST EXAMINATION				SECOND EXAMINATION			
	Age	Number of teeth involved	Number of pits and fissures		Age	Number of teeth involved	Number of pits and fissures	
			Total	Average per tooth			Total	Average per tooth
54–77	11	34	52	1.53	12	12	5	0.42
1–26	12	18	10	0.55	13	5	1	0.20
27–52	13	30	24	0.80	14	9	3	0.33

Summary E

*Data for age groups in Summary D; for results of both examinations combined**

AGE	NUMBER OF TEETH INVOLVED	NUMBER OF PITS AND FISSURES		AVERAGE PER TOOTH, AS RECORDED FOR AGE GROUPS, IN TABLE 19, MONOGRAPH III
		Total	Average per tooth	
11	34	52	1.53	1.54
12	30	15	0.50	1.52
13	35	25	0.71	1.23
14	9	3	0.33	....

* Only children having all first permanent molars in place are included in this calculation. There was only one child at an age less than eleven in this school group (Case 53).

III. RESOLUTIONS OF PROTEST AND CORRECTION ADOPTED BY DENTAL ORGANIZATIONS

A. American Dental Association: Denver, Colorado, July 24, 1930

Whereas, in School Health Research Monograph Number III entitled "Public Health Aspects of Dental Decay in Children," the American Child Health Association has published numerous statements that ignore past dental researches, disregard clinical observations and experience, and misrepresent current dental practice; and

Whereas, some of the data, opinions, assumptions, conclusions, and advice in Monograph III would, if generally accepted, soon undermine present efforts to promote oral health service for children in public schools and under other public auspices, and would also block all new efforts to advance measures for the betterment of child health by oral means; and

Whereas, if the unwarranted and careless statements in Monograph III were allowed to stand unchallenged and uncorrected, dentistry would be degraded in public respect and the usefulness of dentistry in public health service in general would be impaired; therefore be it

Resolved, that the American Dental Association cannot accept as scientific or trustworthy the assumptions and conclusions in Monograph III, for they conflict with the findings of dental researches, and with clinical observations and experience, that have been recorded by qualified investigators; and further be it

Resolved, that copies of these resolutions be sent at once to the officers of the American Child Health Association and of the Oral Hygiene Committee of Greater New York, also to dental, medical and other health service journals for early publication, so that dental, medical, and lay judgment on the import of Monograph III may be suspended until a detailed statement regarding the methods, data, and conclusions in the Monograph can be published.

B. Mouth Hygiene and Preventive Dentistry Section of the American Dental Association: Denver, Colorado, July 21, 1930

Whereas, the American Child Health Association has published a Monograph entitled "Public Health Aspects of Dental Decay in Children," in which it is stated that public health administrators are faced by propaganda claiming that a policy of filling deciduous teeth will protect the first molar against decay of the occlusal surface; and

Whereas, they arrange their data to show public health administrators that such propaganda is unreliable and not in accord with facts; and

Whereas, no dental propaganda carried on by any of the official dental educational organizations has ever advocated such a policy; and

Whereas, the publication of such a statement by the American Child Health Association is untrue, unwarranted, and detrimental to the best interests of public health, and particularly of children's health; therefore be it

Resolved, that the Mouth Hygiene and Preventive Dentistry Section of the American Dental Association states that there never has been any official or responsible propaganda making such claims; and be it further

Resolved, that these resolutions shall be sent to all dental and medical journals with the request for their publication.

C. American Society for the Promotion of Children's Dentistry: Denver, Colorado, July 24, 1930

Whereas, the title of Monograph No. III published by the American Child Health Association, "Public Health Aspects of Dental Decay in Children," would lead anyone to expect that the health of the child had been carefully studied in relation with dental conditions; and

Whereas, no information of this kind is touched on; and

Whereas, some of its statements are false, while others are misleading, and those which are correct have long been known to our profession; therefore be it

Resolved, that the American Society for the Promotion of Children's Dentistry go on record protesting against this publication as being unreliable, unwarranted, and misleading; and be it further

Resolved, that such publication is detrimental to the best interest of child health; and be it further

Resolved, that this preamble and these resolutions be sent to all medical and dental journals with a request for their publication.

PROBLEMS IN DENTAL RESEARCH[1]

WILMER SOUDER, PH.D.

Physicist, National Bureau of Standards, Washington, D. C.

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AMERICAN DENTAL ASSOCIATION ACTIVE

When I appeared before this Society on two previous occasions,[2] my papers were limited to dental amalgam. Some of you will recall the attempts to show the possibilities and values of a safe specification for this important material.

Since those occasions the American Dental Association has become actively interested in this subject,[3] has rated a large number of amalgam alloys, has submitted definite specifications for the material, and

[1] A review of some of the discoveries and problems resulting from the cooperative dental research at the National Bureau of Standards. Read at a meeting of the Section on Preventive Dentistry, First District Dental Society of the State of New York, Pennsylvania Hotel, December 12, 1929. Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] December 1925 and December 1927. *Journal of Dental Research*, 1927, vii, p. 173.

[3] *Journal of the American Dental Association*, 1929, xvi, p. 583; 1930, xvii, p. 115.

has secured a remarkable cooperation from many of the manufacturers, namely: an agreement on the part of the manufacturers to certify that certain brands of amalgams comply with the specification. This result alone is, I am sure, worth the cost of all research made at the Bureau of Standards by the American Dental Association during the last twenty months.

LABORATORY TESTS WILL ANSWER MANY QUESTIONS

There is a decided trend toward a more comprehensive study and a more rigid test of technics; for example: research laboratories are testing amalgams mixed by amalgamators; amalgams forcibly ground in a mortar during amalgamation; amalgamated masses continuously

TABLE 1

Dimensional changes accompanying inlay technic

MATERIAL	TEMPERATURE INTERVAL	LENGTH INCREMENT
		per cent
Wax	28 to 40°C.	+0.72
Investment	(Setting)	+0.20
Investment	40 to 350°C.	+0.31
Total increase		+1.23%
Contraction of gold (to be compensated)		+1.25%

mixed over long periods during condensation; reworking partially-set amalgam, with mercury added to extend the plastic period; application of excessive packing pressures; and numerous other practices just as injurious to amalgam. Study clubs, dental schools, and testing laboratories properly equipped for testing amalgam, can easily prove most if not all the above practices to be unsafe. Defective amalgams and defective technics are being eliminated. Sufficient data are now available to prevent anyone from being misled in this field.

GOLD-ALLOY RESTORATIONS

But today I am not restricted to a discussion of amalgam, and therefore plan to spend most of the time discussing the larger subject of gold-alloy restorations and accessory materials used in connection with

these restorations. It is unfortunate there are no final specifications for all these alloys and accessory materials. The best we can offer are tentative specifications,[4] which no one regards as final, but which everyone considers better than no specifications. Perhaps some requirements are too rigid, but there are few indications that any are too loose. Specific instances of these specifications are given below.

Today no one asks why specifications are desirable or important in dentistry. The advancements made during the last three years in the inlay field have convinced many (not all) that inlays can be made to fit. Three years ago the accompanying *Table 1* was given the profession as one method of making inlays fit:[5] Since that time we find a decided revival of interest in this work. We are wondering why inlays should not last fifty years instead of five years, and why it should be necessary to re-make 30 per cent of the inlays instead of perhaps 3 per cent.

FAILURES ASSURED BY DEFECTIVE MATERIALS

Combinations of materials are possible where most if not all of you would have to make-over 100 per cent of your inlays; and the "make overs," if the same materials were used, would be no better than the originals. Why? Because the physical properties of the investments, waxes, or other accessory materials guarantee failures, or results so poor you would regard them as failures. Just one illustration will make clear what I mean. The effects of a shrinking investment must be added to the shrinkage produced by the alloy after casting. On this point there need be no argument, and we shall doubtless agree that shrinking investments should not be sold to the dentist. But our agreeing to this does not prevent their sale.

STANDARDS OF QUALITY NECESSARY

Until we set up a definite standard of quality, we fail to protect the man producing good materials; for, so long as there are no recognized standards, he has no positive means of showing the superiority of his product. The selection of dental material should be made just as

[4] For gold alloys: *Journal of the American Dental Association*, 1929, xvi, p. 627. For investments: *Ibid.*, 1930, xvii, p. 780.

[5] *Journal of the American Dental Association*, 1927, xiv, p. 189.

scientific as possible; and there is no better method than by establishing standards, and purchasing on quality. The American Dental Association is now working on this most important item of specifications, and hopes to develop satisfactory standards as rapidly as possible.

You, as dental artists and architects, have need for more rigid specifications than builder's architects do. You cannot permit defective materials or technics to interfere with your higher professional services and decisions. Defects in materials and technics are sure to disturb and reduce the efficiency of your diagnostic and advisory services. You need all the help possible from science and art.

DIMENSIONAL VARIATIONS IN IMPRESSIONS AND MODELS

Suppose we pause to inspect the technic for some work in partial restorations. Regardless of whether it is by single-piece casting or assembled castings, we start by taking the impression. If this is taken in a warmed plastic material there is surely a contraction or distortion, or both, as the wax or modeling compound cools. The impression is not an exact impression.[6] This discrepancy is often corrected (approximately) by adding a softer impression compound, or by flaming the surface and making a second attempt at taking the impression. If the impression is taken in a plaster or other setting material, in which there is no large temperature variation, the first impression may be better than that in the compound, but the crystallization-changes in the plaster may cause a slight distortion in the impression. Let us now assume the model, when poured, is an exact reproduction in dimensions of the mouth relations.

Waxing up for the final gold restoration is a matter of opinion. Some prefer the thinner flat gages of wax, others the heavier gages, which they later carve to elliptical sections. There might be nearer agreement on this if there was less occasion for adjustment after casting. But sectional thicknesses is not the problem to which I am directing your attention. Suppose the model, when heated to burn out the wax, contracts (a very common happening), and further that the cast gold alloy contracts: if you cast all in one piece you will have no difficulty in seeing the discrepancies. If you cast in sections, and

[6] *Journal of the American Dental Association*, 1929, xvi, p. 1829.

assemble by soldering or fusing, there will be less discrepancy, but are you sure the distributed discrepancy is negligible? There are some who hold that exactly-fitting bridges or appliances are not satisfactory, but that a certain state of compression or massage of tissues must be provided by a definite misfit or modification of dimensions.

Regardless of these, there are two uncontrolled variables or vulnerable points in this work which must be mastered, if we are to make the restoration fit or not fit by a definite amount. These are changes in dimensions of the model-investment mold on heating, and shrinkage of alloy on casting and cooling. The expansion of the wax pattern, so beautifully controlled for the inlay, is not available here, at least not with the present manner of waxing up on models.

SELECTING PARTIAL ACCESSORY MATERIALS

By a proper selection of the model-material it is possible to produce an expanded model when heated, but up to this time we have no data indicating an expansion of investment, stone, or other model-material, sufficient to neutralize the subsequent shrinkage of the cast alloy. Research Associates[7] of the American Dental Association are now wrestling with this difficulty. A method has been developed which is somewhat inconvenient, but may prove to be one way of overcoming the difficulty. The method is not new, for it has been described by different technicians and manufacturers, but the data supporting or proving the validity of its use were never analyzed prior to that given it by the cooperative research. The method consists in pouring the model from a low-fusing bismuth alloy. This is an unusual alloy in that upon solidification it expands instead of shrinking.

AN EXPERIMENTAL TECHNIC

I am sure most of you are thinking far ahead of me at this instant, and it is needless to continue giving tedious details of the method. Suppose we outline it, then offer a few comments, and close the subject:

[7] Research Associates of the American Dental Association at the National Bureau of Standards: N. O. Taylor, Ph.D., Geo. C. Paffenbarger, D.D.S., Howard S. Berger, D.D.S. Reports covering this work have been published in the *Journal of the American Dental Association*, 1929, xvi, pp. 583, 590; 1930, xvii, pp. 112, 780.

(a) Secure an accurate impression.

(b) Pour a metal model using a low-fusing expanding alloy.

(c) Secure an accurate impression of the metal model, using the same method as in (a).

(d) Pour a stone, investment, or modified-plaster model in (c), using a material that expands on heating. [Remember that model (d) is somewhat larger in all dimensions than the mouth dimensions, and that upon heating it will increase further; in fact, for the ideal technic, the sum of both increases will exactly neutralize the shrinkage of the gold alloy.]

Now let us look over this outline, and see what assumptions and approximations have been made. This is entirely proper in all technical analyses; and until it is done, we have no idea of the limitations or accuracy of the technic. Such an analysis will also indicate the places where improvements are desired, and where further study should be made.

I can give you no analysis for impression-taking whereby tissues are compressed or relieved, or whereby materials are later added for a peripheral seal. It is part of your art, your judgment, and your professional service, to decide which cases require a maximum and which a minimum of these modifications. This leaves the problem of dimensions as the only one for our comments. Perhaps it may be stated by some that there is nothing new in this idea, and so far I agree that it is not new. But I have never found an analysis of the variables. Therefore I offer no apology for referring to it, without giving credit to any one in particular as having established the method; and please do not attempt to give me credit for any part of the plan. As you have doubtless been thinking, the method depends upon a metal model that expands upon solidification, and a second model in stone or investment of a setting material that expands upon heating. Neither of these alone will give sufficient expansion to compensate the gold shrinkage. Now how much expansion is available on each?

MATERIALS MINUS INFORMATION

Dealers' shelves are full of variously colored and decorated packages of these materials, but not one hint is given as to the value of these needed physical properties. I am going to surprise you by

repeating a statement of a manufacturer on this very point: "When the profession decide upon what they want we shall be glad to supply it." I believe he was speaking the truth. Although it does not indicate the highest type of cooperation in the development of dental science, it does doubtless indicate the safest position during this rage of fads and special materials—sponsored by the individual lecturer and the psychological sales campaigns of competing firms, willing to exploit the profession for a few years without any regard for subsequent results.

INFORMATION TO ACCOMPANY MATERIALS

The situation is far from hopeless. The profession is telling the manufacturer what is wanted in dental amalgam. Many have anticipated the need and have supplied safe amalgam for years. Unfortunately many firms supply more than one grade of amalgam, part of which they gurantee to comply with the requirements and part of which is undoubtedly supplied to give certain members of the profession "what they want." If you follow the amalgam developments of the last three months, and during the next three, you will find ample proof of the above statements.

But we have wandered from the two items of dimensions entering partial-denture technic. In October we presented to the seventy-first meeting of the American Dental Association a proposed specification for dental investments.[4] Among other things are requirements for strength and dimensional expansion when heated. If we apply this to the problem before us we shall demand 0.6 per cent expansion of the model investment or stone at 700°C. The materials on the market that meet this requirement are not numerous. Manufacturers should announce within the next sixty days which materials meet this requirement.

EXPERIMENTAL FUSIBLE METAL (NOT FINAL RECOMMENDATIONS)

There are, so far as I know, no data available on the expansion of fusible-metal models as applied to dental technology. Drs. Taylor and Berger, of the American Dental Association's research staff,[7] have experimented with an alloy of the following composition: Bismuth, 55; tin, 15; lead, 30; melting point, 96°C. With it, they have been able to

produce restorations to size. The setting expansion of this alloy, when determined in a plaster mold, is approximately 0.6 per cent. This work is yet in the experimental stage and a more precise value will be given later. You will doubtless enjoy trying some experiments in your own laboratories. Don't quote me as advocating the above technic, as of any value at this time, except for experimentation. One of the members of your Society has raised a serious question regarding its application to dental operations. With this warning, I feel no hesitancy in offering it to you for experimentation. You see the need for materials of definite physical properties where precision is required, and the results of experiments with such materials are interpretable.

"PROPER MATERIALS PROPERLY USED"

All dental reports from the Bureau of Standards may be regarded as pointing to one ultimate goal, namely: "*proper materials properly used.*" There may never be 100 per cent agreement on the first element— proper materials. Professional men seldom agree upon narrow limits of standardization, which is not necessary. A worthy contribution can be made, if we are able to prove certain materials to be defective and to list others, coming within a rather wide range, as safe and entirely satisfactory for use.

The proper use or manipulation of materials is a far more difficult problem to solve. Different clinicians display opposing methods of technics and receive unqualified approval, although each clinician has apparently proven his method to be the only workable technic. Dentists are divided on the technics, and are very positive in claims for the superiority of the method they may happen to prefer. We have one additional function to perform in our research.

LIMITATIONS AND DEFECTS

We must see the limitations, inconveniences, and defects of the various methods, as well as the excellent properties. Unless we do so, we would not be impartial, and would not fulfil our authorization— would not be fair to you, and would eventually lose the confidence of the profession. With this explanation there need be no embarrassment when certain technics are criticized (but not condemned).

CRITICISMS OF INLAY TECHNICS

There are inconveniences in, and objections to, all inlay technics[8] advocated during the last twenty years. In 1926 we showed a method of mixing investment to free it from air,[8] a very desirable procedure for accurate work. The method was too difficult, so we suggested a possible compromise. At the same time we showed castings made to exact dimensions, and fitting perfectly, by using a thermostated air-bath and carrying out all operations at exact temperatures. The exacting details are too severe for most laboratories, and are therefore not to be insisted upon as suitable for all conditions.

Numerous modifications of the original Van Horn water-bath have been proposed, but these have objections, e.g., an M.O.D. wax pattern is packed in a mass of investment, and is supposed to push back the stiff investment as the wax pattern expands and as the investment solidifies. Thin sections on the pattern are supposed to force back this investment without any distortion to the pattern. It is difficult to see how this can be accomplished in all cases.

Expansions of wax patterns are sometimes secured by pouring warmed investments over the patterns, but this is subject to enormous variations.

Inlays cast in thin-wall sections and of soft material may be forced and burnished to the cavity in excellent adaptation, but there would undoubtedly be advantages in casting to a more nearly accurate dimension, and not having to do so much stretching and burnishing. I want you to know that we study all phases of these problems.

INLAY TECHNIC TO BE DEVELOPED

Now what is the answer to the inlay casting technic? It is proposed to have the profession answer. The cooperative research expects shortly to have impartial operators try the numerous possible methods, and advise regarding their experiences.[8] When these data are available it should be possible for each dentist to select the method most appropriate for his particular conditions. Until we do this we shall be unable to advise intelligently regarding materials properly used.

[8] See the report of the Research Associates of the American Dental Association, to appear in future issues of the *Journal of the American Dental Association*.

When the various subjects are given this dual consideration, "*proper materials properly used,*" we are entirely willing to leave the case with you. To attempt to do more would not be ethical, and no member of the research group would want to be regarded as unethical in even the smallest matter.

ADDITIONAL RESEARCH BEFORE FINAL ANSWERS

I know many of you are disappointed in not finding in this essay the last word on all dental problems. If you have observed an emphasis upon the necessity for data on the physical properties of materials, and an attempt to show the application of these data to dental operations, I am quite satisfied. When all of us begin studying the problem in this manner we shall find the answer more quickly, and at less expense than by any other method. This will require time—perhaps five years, possibly twenty-five. The value will be many times the cost. The latter we shall soon forget, but the former shall be the contribution of this generation to dental science.

DISCUSSION

H. C. Ferris, D.D.S. (New York City): I am interested in orthodontia, and in the power of springs.

Dr. Souder: You can get excellent alloys for springs. The wrought materials give 145,000 pounds per square inch for tensile strength, whereas the best cast-materials give only about 90,000. There is 40 or 50 per cent more value in the wrought wire than in the cast wire. The percentage of elongation is likewise superior.

A. S. Litten, D.D.S. (New York City): I understood Dr. Souder to say that the so-called Van Horn water-bath is supposed to cause wax to expand so as to make up for a deficiency due to contraction. It is my impression that the bath is to keep the plaster from contracting and in that way prevent setting.

Dr. Souder: I don't understand it that way. The idea is to get a bath temperature above room-temperature, and thus expand or enlarge the wax pattern.

Finn J. Bronner, D.D.S. (New York City): It seems to me that, if we should ask all the questions we would like to have answered, we would have to spend the rest of the night here. There are very many puzzles for teachers and practitioners. What I would especially like to know is whether Dr. Souder thinks we have the manipulative skill and the facilities for making a fair inlay at the present time.

Dr. Souder: Yes, indeed.

Dr. Bronner: What percentage do you think we would have, figured on shrinkage and expansion, with the average equipment and manipulative skill?

Dr. Souder: I don't think there is a man in this audience who doesn't have better manipulative skill than I or any of my assistants. We are not trained to handle these materials. I think you all have fingers that are far superior to mine, and that you can make inlays, adapt them, make the wax patterns, and get the margins, in far better condition than any of us can; but if you don't have the proper materials, you are doomed to trouble or to failure. Some people never have to make inlays over. We will rule those out right away. I am interested in the man who makes it over and conscientiously says: "I know it isn't satisfactory, and I am going to make this appliance or this inlay over again." As to what your rating should be on that, I can't say.

Dr. Bronner: With the facilities at hand, what success would the average practitioner have?

Dr. Souder: We don't know what to recommend; we don't know what to suggest. It would be nice if we could say: "Buy a water-bath and a few other things, and your troubles will be ended," but we know they won't be ended. We will have to wait a year before we can answer that question —perhaps we can answer it then. We can take a dental man into the laboratory, as we have from a state university, and in three months teach him an entirely different language. When he first came in he talked about a certain man's alloy, or about a certain brand of material, but after he had been there a short time, he talked about a material having a certain percentage of elongation or an investment having a certain expansion. He now says: "If I have an investment that gives a certain expansion, then I must have a wax that gives a certain expansion." He talks about the values

of the material instead of what is on the package of the material. This man came into our laboratory and, inside of three weeks, was doing finer work than any of us had done, and doing it consistently. He had the art, which you spoke of before, and it took him only two or three weeks to get the mental analysis and an understanding of what all this research means in dental art.

In my opinion the average practitioner is not over 50 per cent as successful as he could be, if he used proper materials and efficient technics.

W. H. Leak, D.D.S. (New York City): Are there any publications by your Department that would be of value to us?

Dr. Souder: The publication covering the work done in cooperation with the Weinstein Laboratory is for sale by the Superintendent of Documents, and is known as Research Paper, Bureau of Standards, No. 32, and costs 35 cents. The work done in cooperation with the American Dental Association is appearing in the *Journal of the American Dental Association.* There will be an article in January and perhaps in February, and we hope to continue them through the year. The Government publications are not printed so often for two reasons. For example, Research Paper No. 32: the Superintendent of Documents has sold about 2000 or 3000 copies, which isn't a very large number. It took us about six months to get the paper, in press, to the Government printer. There was a six months' delay in printing. The *Journal of the American Dental Association* has a circulation of about 40,000 and a paper sent to it should be out within two or three months. For these reasons the reports will appear first in the *Journal of the American Dental Association.* We prefer to handle them first in that *Journal* and then summarize them later. It may be two or three years before the Government will issue another report on this work, but data will be available to you meanwhile in your journals.

T. V. Joseph, D.D.S. (New York City): I have a notation here: "The shrinkage of the gold (1.25) would be compensated by the 0.6 expansion of the investment at 700° and 0.6 on the model or on the wax." That, then, just about compensates for the shrinkage of the gold. I should like to ask whether there is a report in any journal of the work done previous to the work that will come out in January and February?

Dr. Souder: Yes, Research Paper No. 32 is available. There may be some misunderstanding about this model, where the 0.6 per cent expansion

came on the model. This was the fusible metal poured into the impression, and the fusible metal gave you that 0.6 per cent.

Dr. Joseph: What I was trying to correlate were the factors that compensate for the discrepancy in the shrinkage of gold. The percentages would be: wax 0.6, investment 0.6; or fusible metal 0.6, investment 0.6.

Dr. Souder: That is one way of doing it. We don't recommend any particular way. You can make it 0.5 plus 0.7, or 0.4 plus 0.8, but there is no available investment that will take care of all the expansion needed; and, so far as we know, there is no wax that will take care of all of it. Of course, if someone could make a wax or an investment that would do so, that would be a wonderful thing.

Dr. Joseph: Do you find that the best investments on the market accommodate for the shrinkage of gold at 700°? Do they deteriorate above 700°?

Dr. Souder: Some of them will go above that temperature and be quite firm. The investments now on the market will not compensate over 0.7. The gold shrinkage is 1.25.

Dr. Joseph: But they all deteriorate as they cool.

Dr. Souder: When you cool an investment, that is a different matter. Strange as it may seem, it is stronger when hot than after it cools.

Dr. Ferris: Where can we get some information on the physical properties of waxes?

Dr. Souder: We haven't worked on a specification for waxes yet, and the information doesn't come very rapidly. Some of the manufacturers can give the information, but these things are coming slowly and we have to wait for them. Research Paper No. 32 will give you some information on a few waxes.

Dr. Ferris: Where is the American research on this subject, as carried on, by the wholesale dealers?

Dr. Souder: I do not know. Perhaps it does not exist.

S. Blumgarten, D.D.S. (New York City): You showed us a slide containing a curve of the expansion of the investment. I believe it showed that, between 550°F. and 650°F., there was an expansion and then a contraction. I think the greatest expansion was around 1100°F. and up. I have heard various opinions as to the proper temperature at which to cast an inlay. Some have advocated casting it cold, some have advocated casting it between 550°F. and 650°F., and another man has advocated 800°F., while still others have advocated 900°F. and up. What is the best temperature?

Dr. Souder: That is a personal problem for you to decide. The cold mould is weaker and the cold mould is smaller. Therefore you don't want to cast into the cold mould if you want dimension. As to how high you should heat: that depends upon how much expansion you expect to load upon the wax, and how much you are going to get on the investment. If you can get 0.7 or 0.8 per cent on the investment, get it there. Then take the rest of it on the wax expansion, or some other indirect method. This means that castings should be made at around 500° or 600°C. *Table 1* shows a combination for 350°C. This probably loads too much of the expansion upon the wax.

THE PRESENT STATUS OF THE INVESTIGATION OF THE CAUSE, AND OF THE GEOGRAPHICAL DISTRIBUTION, OF MOTTLED ENAMEL, INCLUDING A COMPLETE BIBLIOGRAPHY ON MOTTLED ENAMEL[1]

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The articles in the periodical literature of dentistry dealing with the subject of mottled enamel have been chiefly descriptive of the geographical districts wherein it is endemic, and of the conditions under which it has occurred, the purpose having been to find some peculiarity of the environment, common to the various localities, that might be the causative factor. This purpose has not yet been realized. But the evidence has been so overwhelmingly conclusive, to the effect that the productive influence resides in the drinking water, that the investigation now rests upon this hypothesis. In the articles previously published, the various endemic areas described are so widely separated geographically as to involve no small task for future investigators who might wish to obtain a picture of the distribution of the lesion. The purpose of this report, therefore, is to summarize and condense our information, which will be presented under the names of the different states in our own country, with brief comment particularly as to the known water conditions in the different communities, with such additional data regarding foreign countries as may be available.

It is not assumed that this summary is complete except as to our present recorded knowledge. It is hoped that this publication will bring out endemic districts that have not previously been reported. Such added information would be most cordially received, and is urgently invited.

[1] Read at a meeting of the New York Section of the International Association for Dental Research, Dental School, Columbia University, March 13, 1930. Abstract: *Journal of Dental Research*, 1930, x, p. 268.

The appended summary is arranged alphabetically rather than chronologically. While the communities mentioned are cited as endemic districts, that is, districts in which this lesion of the enamel occurs consistently in native individuals, it is not to be inferred that sporadic cases in single individuals, due to causes not known, may not occur elsewhere. Such cases have been observed, but are extremely rare.

SUMMARY

United States

Arizona. Certain communities in the *Salt River Valley*, in a general way east and north of Phoenix: the occurrence of the enamel lesion is pretty generally associated with the use of water from deep (driven) wells. To some extent in the vicinity of and possibly including *Tucson.* Certain scattered small communities in the so-called *Papago country*, in the extreme southern part of the State. Certain villages inhabited by the Papago Indians. The most intensely afflicted district is on the reservation of the Pima Indians centering at the Government School at *Sacaton*, in the valley of the Gila River, south and east of Phoenix. Here, as previously reported, the affliction includes practically 100 per cent of the Pima children. The water in this district is from surface or dug wells. A complete survey of the entire state is reported to be under way, or to be undertaken, which should definitely locate other afflicted districts, if any.

Arkansas. An examination of the town of *Bauxite* and immediate vicinity was made under the auspices of the Department of Public Health of the U. S. Government, two or three years ago, the results of which have not yet been published. Briefly this community was found to be suffering from a 100 per cent affliction, and the evidence gathered positively associated the lesion with the use of water from deep wells. This community, immediately after the examination, abandoned the use of the water from the three deep wells that previously furnished the municipal supply, and substituted water from an entirely different source, exclusively because of this dental condition.

Bauxite is the second community in the United States to make a substitution of its municipal water supply because of the existence of

mottled enamel, the first having been *Oakley, Idaho* (which see), as described in *Dental Cosmos*, in September, 1925. A re-examination of both these communities will be undertaken after a lapse of six to seven years, following their respective changes in the water supply.

California. Benton Hot Springs, an almost abandoned mining town in the upper Owen's River Valley: only a handful of people are left there, principally Piute Indians; the few afflicted cases were associated with the use of water from a flowing hot-spring. *Montecito*, a suburb of Santa Barbara: only a few cases, but associated with the use of water from a hot spring. Other hot-spring water cases originated in the vicinity of *Las Vegas*, just north of Santa Barbara. *Elsinor Hot Springs:* Dr. George C. Chuck, of Long Beach, reports a definite association with the use of water from the hot spring, the principal source of domestic supply. Warner's Ranch, located in a general way a few miles north of *San Diego:* another small community formerly occupied by a certain Indian people using water from a hot spring. *Maricopa:* no definite information available either as to extent of the affliction or water conditions.

Colorado. A detailed account of the several afflicted communities in this state, with water supplies derived from different sources including both deep and shallow wells, coal mines, running streams, and water high on the mountain range, will not be undertaken in this report. The largest district of consistent occurrence is included in and adjacent to the *Pike's Peak watershed.*

Idaho. Oakley, situated in the south-central part of the state: another community which had used hot-spring water and showing 100 per cent affliction. Following the examination the hot spring was abandoned and a supply from another source substituted, Oakley having been the first community to make a municipal water substitution because of a dental defect. (See Bauxite, Ark.). *Bruneau*, a small community in the valley of the Bruneau River: hot spring water in conjunction with river water.

Illinois. Minonk: a general association with deep-well water.

Minnesota. Graceville: a definite association with deep-well water.

New Mexico. Various small communities over the state, principally adjacent to the *eastern boundary* (Texas). No reliable data as to the water sources, and no definite knowledge of the particular towns afflicted.

North Dakota. Lidgerwood, near the south-east corner: a definite association with deep-well water.

South Dakota. Britton, Kidder, Langford, Pierpont, Andover, Groton: all in the north-western part of the state; in each a definite association with deep-well water. Evidence, similar in a general way, was found in *Aberdeen.*

Texas. The distribution over Texas is so widespread that no detailed cataloging of the communities is here possible, but reports indicate that the north-west portion, known as the *Panhandle,* constitutes by far the most extensive afflicted area in this country, and involves more people. A definite deep-well water association has been reliably established. There are afflicted localities in other parts of the state.

Virginia. Franklin and *Courtland*, both in the south-east corner: deep-well water association.

Other countries

Bahama Islands. Certain of this group have been reliably reported as affected, the water being derived from shallow wells.

Barbados Island. Information is very meagre, but indicates some degree of affliction. No water data.

Cape Verde Islands. The inhabitants of this group are colored Portugese, considerable numbers of whom have emigrated to America and located on Nantucket Island, and certain parts of Cape Cod. The emigrants are derived from only two of the Cape Verde group, namely, the Islands of Brava and Fogo. An examination of a group of these individuals on Nantucket Island revealed that the lesion occurred only in the *Brava* people, and was entirely absent in those from Fogo. No data are available as to the water conditions.

China. Endemic in *North China.*

Holland. Ample evidence indicates that mottled enamel is endemic in several districts in Holland. In 1927, the writer made an unsuccessful attempt to gather definite information by personal endeavor in Rotterdam. During the present year (1930), however, he received reliable reports at the Dental School of the University of Utrecht, to the effect that in Utrecht, and in certain adjacent communities including Arnhem and Amsterdam, mottled enamel is being abundantly

produced. Although lacking definite knowledge, the impression was gained that there seems to be an association between this lesion and the use of water from the sand dunes prevalent throughout this district, from which certain communities derive their water supply.

Italy. A definite endemic area exists in certain regions adjacent to *Naples*, and there is some suspicion that other districts in Italy are afflicted. The water association in the Naples region is conclusive.

Mexico. There is some evidence to indicate that endemic districts are scattered over Mexico, but thus far no information is at hand except that the city of *Durango* is afflicted. There are no data upon the source of the water.

North Africa. Minor evidence indicates that mottled enamel occurs in certain parts of the *desert country* and on the *Sinai Peninsula.*

South America. An amazing prevalence of this condition, covering a very large portion of *Argentina*, has been reported during the past two years by Dr. S. W. Damon, an American dentist practising in Buenos Aires. His findings, accompanied by a wealth of photographic evidence, have revealed what is without doubt the largest endemic territory, comprising the largest afflicted population yet brought to notice, including literally hundreds of thousands of people. In addition to Argentina, Damon has found this condition scattered over other adjoining countries in South America. The water conditions over these vast areas are so difficult to tabulate, and so little is known of them, as to render impossible at this time any attempt at a detailed description, but present indications are in large measure conclusive. It is with intense gratification that attention is called, in this report, to Damon's persistent efforts, and to his exhaustive inquiries into conditions in South American and European countries, in collecting an immense amount of data on this subject.

Spain. More recent inquiries by Dr. S. W. Damon have located several afflicted districts in Spain.

Starting as this investigation did, about 1910, with but one endemic locality definitely known to exist, it is of more than passing interest to note the distribution of this enamel defect over a large part of the United States and into widely scattered areas in other parts of the world. What was considered in those early days to be a matter of

only local interest has become of international importance. There were no known references in our literature to this defect of the enamel until 1902, when Capt. J. M. Eager, of the U. S. Marine Hospital Service made, in the March issue of *Dental Cosmos*, a report regarding its occurrence adjacent to Naples, Italy. The first article upon the subject, other than Eager's brief report, was contributed to the January, 1910, issue of (*Dental*) *Items of Interest*, by the late H. A. Fynn, of Denver, his paper having been read before a meeting of the Colorado State Dental Society in June, 1909.

It is believed that this lesion of the human teeth is unique in that its entire descriptive literature originated scarcely more than twenty years ago, which has made it comparatively easy to collect and tabulate the publications relating to it. Having accomplished this, a compilation of future articles will be relatively easy through the medium of the efficient Dental Index Bureau. The appended bibliography is believed to be complete to date, and is presented for the purpose of facilitating access to all the writings on the subject.

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PROSTHETIC DENTISTRY[1]

A Symposium

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Philadelphia, Pa. *New York City*

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I. PRESSURE BALANCE IN DENTURE CONSTRUCTION

Norman Essig, D.D.S., Philadelphia, Pa.

It is not my purpose to give you a long paper this evening, nor to make what I say appear as a scientific essay, but rather to bring before the Academy certain plain fundamental facts that are being very much neglected. Our work as prosthetists has never attained the accredited importance it justly deserves, because we are divided in the way we regard these fundamentals. Some of us have gone to extremes while others have not gone far enough. Many complicate matters as they go along, while others have not taken advantage of the many simple phases of denture construction that have been crying out for recognition.

The entire field of denture construction has undergone a vast revision in the last twenty years, but the underlying principles have been somewhat befogged by more or less scientific investigations involving the use of complex paraphernalia, supposed to measure scientifically the anatomical function so important to the happiness and comfort of our patients. In our effort to benefit mankind we have, to an extent, forgotten the personal-touch work, which, in the mind of your

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essayist, is the all important feature in reproducing the radius of action that is the right of all who wear dentures, and have to depend upon such devices for their health and comfort. These investigations have been a tremendous assistance to the prosthetist, and have no doubt been responsible for the revision just mentioned. Our own mental attitude toward the subject has also undergone a revision, and to-day we are regarding with a different eye and hand the adjustment of our dentures. What we would have considered a complete and satisfactory adjustment some years ago seems unsatisfactory and incomplete to-day. There has been a tendency to work out a formula for denture construction which, I fear, has not been entirely advantageous, and we have depended upon our ability to influence the patient and to explain in a somewhat vague way what is before him or her. Without realizing it, we have depended upon both the adaptability of the patient and the fact that it is possible and often expected that a certain readjustment of function to mechanism will take place in the mouth in time. In other words, the patient must and will get used to the denture we make.

To-day, when teeth are extracted for so many reasons and in such large numbers, we have completely ignored the natural occlusal planes, and take no means of recording such planes before the natural teeth are extracted. Later, when the teeth are replaced, we clamor for the formula because we have no means of re-establishing the conditions that lead to comfort and efficiency, to say nothing of the artistic phase of the situation. Hence the changes in appearance due to tissue loss, and to the muscular effort attending the sacrifice of function to mechanism, which are inevitable when a formula is interjected into the work of the dental prosthetist.

The part of denture construction that I have selected for our consideration has been suggested mainly by a survey of some difficulties encountered in actual practice, and also of some that have beset others when my position has been that of a silent spectator. It is impossible to cover the subject in one paper. Therefore my purpose can best be accomplished by drawing attention to some of the underlying principles that govern and control both the partial and the entire denture.

Possibly nothing is more responsible for success or failure than the

maintenance of a proper sequence of events in the construction of a dental prosthesis, as it progresses, and care in the details of construction from the original survey in the mouth to the finished denture, both as to its value and appearance. Each step in the sequence should be a preparation for the next, and based upon phenomena in the human mouth. So much may be lost between these periods, in one way or another, that we may not be able to apply properly either the basic principles or the engineering features to be embodied, without which neither partial nor entire denture can be a success. In all cases, there should be an adaptation of mechanism to function, and not a sacrifice of function to mechanism. This is perhaps more important in a partial denture than in the full plane, although in some ways our task in the former is simplified by the remaining teeth, depending on and governed by the way these teeth are distributed throughout the mouth; and whether the bite has to be changed after the patient has gone for a period of years with what may be called an abnormal occlusion (loss of molars and bicuspids), but which in reality is a readjusted closure caused by the loss of important teeth in the masticatory apparatus.

We must realize that the changes continually going on in the mouth take place very slowly. Readjustments of the muscular tissue, and of the hinge-like mechanism that allows mandibular freedom of movement, effect corresponding readjustments—simultaneously and at the same rate of speed. It is difficult and often undesirable to require our patients to change their methods of mastication. Even in the most favorable and simple partial denture it should be our effort to maintain the occlusal plane on which the patient has been accustomed to masticate, if no harm comes of it. This, to be sure, cannot always be done accurately. But where the remaining teeth serve as a guide, a little close scrutiny will put the operator on the right track. In any case, the denture should be introduced as soon as possible after extraction.

Our difficulties multiply to a greater extent at and after the time when the case becomes a bilateral extension, and this type of denture will be stressed. In either the upper or lower jaw, or both, it requires more skill and greater care to re-establish the occlusal plane upon which the mandible can function, without interfering with satisfactory movement during mastication and without abrasion of the underlying tissue

under stress, because the remaining natural teeth maintain the occlusal plane in the interior part of the mouth, while we struggle to create a curve upon which the mandible can function, more or less arbitrarily, in the posterior region, which may be a curve or set of curves entirely different from those in the remaining anterior natural teeth. Also, let us take, for example, a bilateral extension in the upper and lower mouth, and suppose that the patient has asked for a duplicate of the upper denture after having had a satisfactory pair of dentures for some time. The old lower will require infinite readjustment to make it as comfortable and efficient as it was with the old upper denture, and the two are not interchangeable. This is especially true if the artificial teeth are increased in number in either denture, and still greater complications arise if any change in bite is required. This condition presents itself in a large majority of cases. The bilateral extension is very often accompanied by a change in the resistance of the upper and lower natural teeth, with retrusion of the mandible, impingement on the ear, etc., together with different degrees of closure affecting the intercartilaginous pads at the mandibular hinge. In fact, the whole anatomical relationship has readjusted itself and is capable of further readjustment, otherwise few dentures, either partial or entire, could be worn. The ability to masticate food without pain or discomfort is a question of balance in occlusion more often than otherwise, and is borne out by the fact that has already been stated—a lower denture that has been worn a long time has to be entirely readjusted when a new upper is made, even if the patient has pronounced it comfortable when the piece is not actually in use for mastication. Some lower dentures, while not uncomfortable when the mouth is at rest, are of no use whatever for the mastication of food because of the restricted action of the mandible, and the misapplication of the force necessary to divide edible materials of a refractory nature. Often the patient is able to get along fairly well with care, but is denied the free exercise of the masticatory function that makes the daily meals a pleasure rather than an effort. We must avoid this state of affairs, which is often not a matter of cusp formation or interdigitation, but lack of pressure balance, which causes instability and consequent drifting during mastication.

A lower denture supplying the biscuspids and molars can, in many

cases, be worn satisfactorily without any means of attachment, if the correct pressure balance during mastication is maintained. Why should it not be stable if an entire denture, having no means of attachment, can be made comfortable and efficient? To be sure, we are always willing to add to stability by such means as can be employed to keep the partial lower from drifting. This usually manifests itself by the tendency of the plate to slide posteriorly, drawing the mandible with it as the patient accommodates the opposing teeth to the artificial ones as the denture works backward. This is often due to the fact that the bites have not been milled in. The backward drift often leaves a space between the denture and the ridge, which is not only very uncomfortable but allows the soft integument to become sore and inflamed. The underlying tissue often follows the outline of the denture, and at times the denture is quite useful for mastication after it could justly be called a misfit. Replace even the best fitting denture on the model upon which it was made, and, after it has been worn for some time, one can readily see how subtle are the changes and how the denture has accommodated itself to the mouth. This is espeially true if clasps are used, and orthodontic changes take place in the teeth to which the clasps are attached.

The foundation for comfort and stability is laid when the bite is taken in all dentures, partial or otherwise. If this is done accurately and correctly, many dentures will need no clasps or other attachment to stabilize them. In taking a bite, the wax must be absolutely controlled either by the base itself if it be a gold denture, or by a swaged metal trial-plate if rubber or similar material is used. These accurate and stable trial-plates, with the wax bite-block sealed rigidly upon them, prevent the wax from squeezing out under the pressure of the force necessary to attain accurate closure. This makes possible the actual transfer of the bite to the model, with a minimum of distortion when that step is taken. The bite-blocks should be no thicker than the artificial teeth to be placed in the space left by the extraction of the natural ones. By this method the patient is not confused by a huge mass of wax, can more readily find the natural closure, and can talk to the operator and answer questions, aiding in his efforts to attain true and accurate pressure-balance, without which there is likely to be continuous faulty pressure-balance, with strangulation and marked ab-

sorption on both ridges, to say nothing of the discomfort endured by the patient. It is well, when the opportunity offers, to direct our own movements in these cases and never extract all teeth in the upper and lower mouth at the same time. By this I mean that the teeth in the upper mouth should be retained until the lower denture is finished, or vice versa, so that the artificial teeth can be ground and set up to the natural ones, thereby retaining the original surfaces as nearly as possible and maintaining in both dentures the original occlusal plane upon which the patient has been accustomed to masticate. The maintenance of this occlusal plane does much to prevent dislodgment of the denture during mastication, while care and judgment in the length of the artificial teeth help to correct the difficulties in the manipulation of both dentures during mastication. To do otherwise is to throw away a certainty and take a chance.

The cusp formation in the individual tooth in partial cases is a guide to the correct closure. But undue contact with other points may interfere with mastication and cause abrasion, by interfering with the lateral excursion of the mandible, changing the pressure balance when that member makes a movement, if the curve producing such surface is not carried to the limit of the mandibular excursion. Here let me remind you that each plane upon the surface of a natural tooth represents are arc of a curve, interrupted or otherwise, but produced by wear when the mandible performs one or more of its functions. What has already been said about pressure balance has a tremendous effect upon the teeth that sustain the denture by means of clasps or other attachments to stabilize it; and I am firmly of the opinion that lack of stabilization is often the cause of failure of the attachment. It certainly is so when the fixed clasp has been used, and has caused this method of attachment to be criticized unjustly. In the upper mouth there is often a condition that admits of no other form of attachment than the clasp. In the lower mouth we often have the option of the labial bar-plate, which, as many of us know, is a bar encircling the labial portion of the alveolar ridge in a bilateral extension that, with the aid of gravity, gives wonderful support. In these cases, clasps are not indicated, as we make a clasp of the denture itself; and the area clasped is the alveolar ridge below the free margin of the remaining anterior teeth. This method of stabilization prevents the denture from slipping backward

under pressure, in turn affecting the upper denture, which is held in better position and alignment by the interdigitation of the teeth and the occlusal plane upon which the two dentures function. I cannot too strongly recommend this form of attachment. The movable clasp has its place and its advantages; it prevents undue stress of individual teeth when there is faulty pressure-balance, and may be used in either the upper or the lower mouth. Any form of compensating attachment, however, must leave the tooth or teeth to which it is attached entirely without stress, or it fails of its purpose. It is not so much that the individual movement of a tooth is denied, as that any form of attachment that allows the transmission of force, owing to incorrect pressure-balance, also fails of its purpose.

Summary

Whenever a subject is presented for consideration, a few important facts represent its sum and substance, and can be epitomized. Let us see what we have in this paper:

Pressure balance is the greatest factor in the stability of partial dentures. Through pressure balance we can often eliminate the different forms of attachment.

Pressure balance can be had only by a correct bite taken with a trial-plate that is as accurate as the finished denture, in order to control absolutely the wax upon which the bites are taken.

Whatever lateral movement the patient is able to take must be unrestrained and unobstructed in the excursion of the mandible through the occlusal plane and compensating curve—best obtained by milling-in the bites with some abrasive material incorporated in the wax.

A denture of any kind must be subservient to anatomical function. Certain simple but definite engineering principles must be incorporated in its construction.

There must be no sacrifice of function to mechanism.

The life of any tooth to which a clasp is attached is more at the mercy of pressure balance than of adaptation of the clasp itself.

In the bilateral extension, the labial bar-plate is probably the best and most stable of all dentures.

The force exerted in mastication must be in the same direction as that exerted in the natural teeth; namely, through the long axis, and in conformation with the triangle or cone that definitely fixes the arc of the curve upon which teeth function, and compensates for the fact that the lower arch is larger than the upper.

Unless occlusal balance and the ability to exert all the pressure possible is borne in mind, there will always be abrasion and soreness, together with undue and undesirable absorption of the ridges, owing to strangulation. (This is the cause of many methods and much literature.)

Older persons bring into play the lateral excursion more than younger patients.

An effort must be made to reproduce the mandibular path and the peculiar freedom of movement of the unrestrained natural excursion of that organ, as much for the actual efficiency of the denture as for its balance, and its comfort for the patient.

There is only one way to appreciate fully what is meant by "comfort," "efficiency", and that is for the operator to wear the type of denture referred to. Then he will neglect no opportunity to get correct articulation and pressure balance by making many preliminary steps and much final adjustment directly in the patient's mouth. When this is done, there will be fewer changes in the human countenance as time goes on.

II. ESTHETICS IN DENTURE CONSTRUCTION

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The field of full-denture prosthesis is beset by numerous and varied problems. To go back a moment to first principles of the art, we find it generally conceded that full-denture prosthesis is undertaken for three main reasons; namely, to restore the patient's appearance, to enable him to enunciate properly, and to restore masticatory function. The third factor occupies the most exalted position, if we are to judge by the attention given to it, for volumes have been written upon the various methods of impression taking; countless clinics have been given on the proper method of registering central occlusion; and prominent prosthetists have waxed loquacious and sometimes wrathy on the sub-

ject of anatomical articulation, and by whose machine it can best be reproduced. We are all deeply appreciative of the painstaking research that has resulted in definite technique for the important groundwork steps of impression-taking, and registration of both central occlusion and mandibular movement, for we are thus enabled to construct dentures that function properly and are comfortable. But, unless the result obtained fulfills the esthetic requirements, does the patient receive a true and full professional service? In concentrating on efficiency and letting the esthetic result fall where it may, may we not neglect or at least pay far too little attention to simulating natural appearance, and so commit a grievous error? The standardized and stereotyped set-up with which we are all too familiar is so far removed from an esthetic restoration as in many instances to border on the grotesque. It is the purpose of this paper to present, at least in part, suggestions for a technique that will enable us to produce dentures which will avoid some of the more glaring errors of the past.

In striving for the desired esthetic result, we need concern ourselves very little with the posterior teeth. It is fortunate that such is the case. Ideal dentures present a pleasing appearance, but also function efficiently. Since the burden of balanced occlusion mainly rests upon the posterior teeth, we are able to arrange them so as to give the maximum amount of efficiency with a minimum of interference in the proper esthetic effect. Then, by placing the anterior teeth (which are relatively much less important in function, but extremely vital in establishing proper appearance) in an arrangement suitable to the case in hand, we are often able to achieve a result which, in a measure at least, approaches our ideal. It will be found that, in a vast majority of cases, artificial dentures which most closely imitate the natural dentition in appearance are those that best harmonize with the patient's facial contours and characteristics and, in so harmonizing, produce the required esthetic effect. By this is meant that the natural dentition should be imitated not only in the shape and coloring of each individual tooth, but also that the arrangement of the teeth should be as close as possible to the arrangement of the natural dentition.

In order to produce dentures fulfilling these rather exacting requirements, data must be secured from which to work. The following steps are suggested as aids in obtaining proper records. Photographs—one

in profile and another in full face, with perhaps a third taken from an intermediate angle—are made previous to the extraction of the natural teeth, with the lips in a position of rest to register the external appearance we shall endeavor to reproduce. If possible, other photos, with the lips drawn back to show the teeth, are also obtained. These pictures may be made in the dental office. Those that register only the external appearance are not difficult to obtain. Modeling-compound impressions of the teeth in their natural positions, together with the bite in pink wax for use in articulating the models, are secured. A valuable study model, to which reference may later be made, is taken by moulding modeling-compound over the labial surfaces of the anterior teeth with the jaws in central occlusion, which, when run up, gives a single model showing the over-bite, over-jet, and (if care be taken to run the compound well up on the gingiva when taking the impression) a good reproduction of the investing tissues. The shade of each individual tooth is also noted—not merely of the central incisors, but also of the laterals and cuspids. After the teeth have been extracted, they are placed in their correct positions in the modeling impression, and plaster poured to retain them. An operator who has secured records of the foregoing steps will be ready when the patient presents himself for dentures—a week, a month, or six months later—to construct cases that will really restore his patient's appearance, instead of so altering it as to excite comment.

Impressions are secured by the method that appeals to the operator, proper bites are registered, and the result is transferred to the articulator. It will be found that the photographs of the patient obtained before his teeth were lost may at this time be a distinct aid in establishing the proper height of the bite rims. One note of warning, which perhaps may not be amiss at this point—the upper base plate should be trimmed low enough to provide ample freedom for the fraenum. If this is not done, and the fraenum is forced upward by the base plate, the upper lip does not assume a natural, free position but, because of its strained relation, gives a false profile, a factor that leads to difficulty in establishing the proper lip-line and length of the upper bite-rim. The upper six anterior teeth are now set up, following the casts with the natural teeth in place as a guide for their arrangement. These are then tried in the mouth and the result checked. If they present

approximately the appearance desired as regards arrangement, they are removed from the mouth, replaced on the articulator, and the posterior teeth set up. If the case is one where both upper and lower dentures are being supplied, the lower teeth are set up and the dentures tried in. Now, if the dentures occlude properly, the changes necessary to secure the proper esthetic result may be made.

The anterior teeth are taken from the base, the glaze is ground off, and at the same time each tooth is ground as nearly as possible to the shape of the natural tooth it is to replace. The teeth that, in the natural dentition, showed erosion at the necks are ground to show similar erosion; enamel faults and depressions noted on the labial surfaces of incisors are reproduced on the porcelain; and grooves, pits, and all other deviations from perfect tooth-form, which it may be deemed wise to duplicate in the denture, are now imitated by careful grinding. The teeth, after being carefully scrubbed with soap and water to remove any particles of abrasive which may adhere to the surface of the porcelain, are then ready for staining. Mineral stains are used for this purpose. These are made by a number of different manufacturers and are readily obtainable. The splotches of color and stains present in the natural teeth are painted on the porcelain with a camel-hair brush. Then are simulated, by staining, fine brown lines often running longitudinally on the labial surfaces; green or brownish-yellow stains present at the neck; deeper shades where enamel has been eroded and the dentin exposed; effects often seen where the enamel in its variations in thickness allows the dentin-shade to show, giving a somewhat "spotty" appearance; and white areas of imperfect calcification. The teeth are now fired, and when cool are removed from the furnace. The stain is modified where necessary by touching it up with an abrasive wheel. When these corrections have been made, Ponto glaze or Steele's Super-Glaze is applied, and the teeth are fired a second time. It will be found that this technique of removing the original glaze, painting the stain on the unglazed porcelain, and reglazing over the stain in a second firing, gives results very superior to those of staining over the original glaze. The very desirable effect of *depth* of color is obtained by this method. By judicious use of the glaze, a surface may be obtained which is not too shiny, as stock teeth often are.

The teeth are now set back in position on the trial base (if they have been carefully removed they are readily replaced in their original positions in the wax), and are again tried in the mouth for a final checkup. If no changes are deemed necessary, the dentures take the routine procedures of vulcanizing, taking of the check bite, and milling. The employment of gold filling in dentures meets in some quarters with more or less disapproval, but their judicious use may often enhance the look of "naturalness" we endeavor to produce. In defense of this practice, let us consider how few mouths we see, especially in people of middle age, without a considerable amount of obvious reparative dentistry. An observant person, seeing a perfect dentition, especially in the mouth of an individual no longer young, is inclined at once to suspect that the teeth are artificial, for most mouths show either ravages of decay or evidence of the dentist's interference with caries. Hence, instead of a small amount of visible gold making artificial teeth conspicuous, its presence as camouflage tends to the opposite effect of concealment.

The foregoing explanations cover only those cases where patients present themselves for treatment with some of the natural teeth in place. The question now arises as to what can be used for guidance where the patient is seen after the natural teeth have been lost, and no opportunity is afforded for comparison of an artificial restoration with the original. One factor that often proves of great value is family resemblance. The old adage, "like mother, like daughter," holds true in many cases, and it behooves the prosthetist to take advantage of this important clue in cases where more direct guides are lacking. In a case where, by comparison of facial contours of a parent and an adult son or daughter, the similarity of type convinces the operator that the dental characteristics of the two were undoubtedly nearly parallel, an impression is taken of the anterior teeth of the son or daughter. A plaster model poured from this will give a fairly accurate guide for both tooth form and tooth arrangement. The shades will have to be determined by taking those from the younger person, and increasing the pigmentation to compensate for the darkening in color that occurs as age increases. It must be borne in mind, also, that the factor of abrasion from use is much more evident in the teeth of older persons than of the younger, and this change must be simulated by

grinding. In general, the hints and help received from a common sense application of the factor of family resemblance are extremely valuable and should not be ignored.

For the remaining cases that present for treatment, with neither natural teeth nor heredity to aid, one must resort to a selection of teeth from type, using Dr. J. Leon Williams's formula of corresponding face-form as a guide. This selection should be made with the occlusal rims in place for, without the rims, the muscles around the mouth, being unsupported, droop and sag and give a misleading impression of facial outline. With the occlusal rims in place, however, the facial contour is at least approximately normal, and Dr. Williams's formula may be successfully applied in making a selection of tooth form. Proper shading in these cases is often difficult to obtain, as is also proper set-up. Both are arrived at generally by a "trial and error" method, in which different arrangements are set up, tried in, and changes and modifications made until the result is satisfactory. The shape of the arch often gives a hint as to tooth arrangement, and it is well to follow the arch-form for the initial set-up, modifying and re-arranging the teeth from this as a starting point. A comparison of the case in hand with dentures of analogous type, constructed for other patients having similar arch-form or face-form, may suggest modifications that can be made to advantage.

There are several typical irregularities in natural dentitions which, although departing from the normal symmetrical arrangement, present, in the mouths of persons in which they are found, a pleasing appearance in harmony with the facial contours. These include rotated centrals, overlapping centrals, overlapping laterals, centrals inclined lingually (often in association with overlapping centrals), elongated centrals, and crowded conditions especially in the lower anterior teeth. Proper enunciation in speech often causes the prosthedontist considerable concern. Touching this point briefly, it will be found that imitation of natural mouth-arrangement in the construction of dentures, since it supplies the lips and tongue with an environment very similar to the natural one, aids greatly in effecting proper pronunciation and helps to eliminate this particular stumbling block.

The point may be raised that the time required for the changes in form, shade, and arrangement herein described is so great as to make

them impracticable in all but a very few selected cases. Experience shows, however, that the necessary changes consume only about three to four hours in addition to the time required for constructions along "regulation lines." The results obtained, from the standpoint of both the operator and the patient, are so gratifying that the former not only has the satisfaction of producing an esthetic restoration, but also is more substantially remunerated by a patient who realizes that his newly acquired teeth do not broadcast the fact that they are not his own. It is the writer's belief that dentures constructed without constant attention to proper esthetic values even though they function properly, are never a source of great satisfaction to the wearer, and do not reflect very much credit on the practitioner who made them.

III. DISCUSSION[3]

Russell W. Tench, D.D.S. (New York City): Dr. Essig's suggestions are worthy of serious consideration, especially since they come from a man of unquestioned ability and extended experience. The profession at large have not, as he implies, taken advantage of the many little refinements made possible in denture construction since the presentation of findings by that master scientist, Dr. Alfred Gysi, in 1910. This lack of interest, I have observed, is due mainly to the fact that the profession are inclined to depend too much upon the advice of the dental laboratory concerning the design of appliances and to accept the laboratory decision as final. We, as a profession, should not forget that the laboratory, to be truly useful, should be an assistant only, not a guide. The dentist is in duty bound to design and plan prosthetic appliances for his patients. The laboratory, properly used, is a means to execute the ideas of the dentist. This method is probably more costly to the dentist in dollars and time, but the patient is better served when the dentist acquaints himself with the necessary facts to enable him to proceed in this way.

As Dr. Essig also states: it is true that the issue has been more or less confused by pseudo-scientists who have attempted, on too slight acquaintance with their subject, to formulate a single plan for so-called precision technique worked out around a particular instrument. Happily, as these men have gained in experience, their ideas have approached a single focus not so far removed from the original findings of Prof. Gysi. To-day, there

[3] Dr. Tench read a prepared discussion of Dr. Essig's paper. Dr. Collins read a prepared discussion of Dr. Hardy's paper.

is substantial agreement that the first principle in any denture prosthesis is to start with centric occlusion of the mandible, and that the most accurate means of reaching a conclusion on this relation for a particular individual is the Gothic-arch tracing of Gysi—centric occlusion being obtained when the tracing pin attached to the maxillary base rests in the apex of a clean angular Gothic arch traced on a suitable foundation attached to the mandibular piece. Many times in partial-denture prosthesis these records may be dispensed with, as the inter-locking of the cusps of the remaining teeth when carefully observed furnishes a guide to this relation. Certainly, centric relation of mandible to maxilla is the prime essential in establishing pressure balance in any denture construction, if the line of least resistance in working to the patient's acquired functional relation is to be adhered to, as the essayist suggests.

When examination of the patient indicates that the opening of the bite is possible or necessary and desirable, then the remaining teeth cease to be useful guides to centric relation because they are separated by the process. The Gothic arch is then the only remaining reliable means. Opening of the bite, I believe, is desirable in many cases of double bilateral extensions in order to give the patient natural freedom of movement in the use of such prosthetic appliances, and to remove the necessity of developing a compensating curve from a radius so short that the underlying mandibular piece is forced backward, as the mandible assumes a forward position owing to settling of the appliance as time changes the foundation on which it rests.

The essayist speaks of the mandible being forced backward, but this phenomenon has not come under my personal observation. As closure occurs, owing to wear of natural teeth or settling of prosthetic appliances on unstable ridges, the anterior part of the mandible reaches a more forward position and, to use a homely description, the patient's chin comes progressively nearer to the nose. Under extreme conditions of this kind, the condyle head may be and often is forced backward, sometimes with an accompanying bending of the body of the mandible, so as to give the vertical section of the mandible a more obtuse angle in relation to the body proper, which carries the alveolar tissues. This condition may come about from and be aggravated by continued chewing on a few anterior teeth instead of on properly designed appliances that replace the missing molars and bicuspids. Sometimes in this type of case the patient even learns to use the mandible in a new position, which causes the whole member to be pushed forward and results in the condyle's functioning on the eminentia articularis instead of in the glenoid fossa. Such cases are particularly difficult when full dentures are supplied, unless the Gothic arch is used to establish normal centric.

The essayist stresses the necessity and value of making records of the position of the natural teeth before extensive extraction, even going to the length of suggesting that, where extensive dentures are to be constructed for mandibular and maxillary ridges, one denture be made before extracting the teeth in the opposite arch in order to maintain natural position and balance. This is an excellent idea, but is open to the criticism, if broadly applied, that —in cases where the natural teeth to be extracted have drifted into spaces left by the removal of adjacent teeth, and have assumed an unnatural position owing to lack of support—the articulation of artificial teeth to such natural teeth may result in the locking of the new appliances, unless special provision is made for this in a good articulator adjusted to suitable accurate records. This is not meant to condemn the idea, but merely to call attention to the fact that, like all ideas, it needs qualification and special application in particular cases. It is here that the personal equation of the operator comes in, as stressed by the essayist in an early paragraph of his paper. All formulas must receive special application at times. This is why the essayist justly criticises the unwise attempt of some to establish one formula for all cases. It cannot be done.

As the essayist has pointed out, it is rarely advisable, for the reasons he gave, to construct extensive new prosthetic appliances to work against old appliances of the same general magnitude. For the purpose of illustration, prosthetic appliances may be likened to gears; an old and a new gear cannot work as efficiently together as two new ones.

The matter of preserving records of the position of the natural teeth, especially those visible when the patient is conversing, is one of the very important items brought up and used by the essayist. The dentist first seeing the patient, whether general practitioner or oral surgeon, should take good wax impressions of the patient's arch or arches, including all teeth to be extracted, so that the extracted teeth may be fitted into the impressions and casts including them made for future reference. Wax bites may also be used here to advantage. Facial profiles that indicate the fullness of the lips, and the prominence and vertical elevation of the central incisors, are also invaluable. The oral surgeon who sees the patient first will do the patient a service if he follows this procedure, for such records cannot be easily destroyed and are of value if the first attempt made for the patient is unsuccessful and she is obliged to seek further assistance elsewhere. I suggest that this idea be extended to the office of the oral surgeon, because patients who come to him first, if referred to some one else for this work, may during the interval lose their enthusiasm for his services, and get into hands where, through negligence, the patients may not be so considerately treated.

Let me, with the essayist, stress also the necessity of using perfectly fitting bases in taking the bite or any kind of records of mandibular position. No result can be obtained otherwise that is worthy of an ethical office. In vulcanite saddle-appliances, I am following the practice of making up the vulcanite saddles attached to the bar lingual or labial preparatory to bite taking. The finished clasps are placed on their individual teeth, and their position in relation to the saddles and bite-blocks is registered in plaster covering the remaining teeth and bar. For bite blocks I prefer hard compound to wax because it has greater stability and is less susceptible to expansion and contraction.

In dealing with pressure balance, I believe, to obtain this (drawing on blackboard), that the position of the artificial teeth in relation to the edentulous ridge must often be varied from the position assumed by its missing natural counterpart—the artificial tooth must be so placed that it will be directly above the ridge if possible; and for the best result, the tooth had better be set slightly inside of the crest of the ridge if the tongue allows, rather than outside. Here we violate the rule, advocated by the essayist, of adapting mechanism to the patient's habitual function, and call upon the patient to adapt the function to the mechanism. When this adjustment is brought about, the over-all result, as affecting stability strain on abutment teeth and resorption of the ridge owing to stress, is by far the most satisfactory that can be obtained.

In the discussor's view, pressure balance in the final development of the denture involves, in addition to the position of the teeth in relation to their responsive ridges, the harmonizing of interacting cusps in such a way that, regardless of the position in which the teeth of the opposing prosthetic restorations are brought into intimate contact, even pressure will be exerted when the teeth touch, and also when they slide from a retruded or lateral position of the mandible back into centric relation of mandible to maxilla. If this is to be obtained with the least effort, it requires, from my point of view, the use of a means of measuring mandibular positional relations in functional range, and of recording these relations in the mechanism of a suitable instrument, such as the Hanau Kinescope or the Phillips Articulator. While such a development can be effected in the mouth alone, the procedure would require more skill and personal intuition than the discussor or the average dentist possesses. The instrument is a great help and time saver under such conditions.

The summary offered by the essayist is concise. With it your discussor is in full accord except that he has not been able to feel that he could make use of the labial bar in all cases, although it is undoubtedly a comfortable and

useful development and occasionally is the only bar that can be used satisfactorily.

Martin L. Collins, D.D.S. (New York City): The problem of esthetics in full-denture prosthesis can better be illustrated by actual completed work than by the written word. Dr. Hardy has done well with his paper. Nevertheless I am convinced that the practical application of his art will more fully exemplify his subject. The writings of the great teachers of art who have attempted to describe the work of the masters have never been so satisfying to me as the art itself. In this respect, this essay falls short of satisfying the subject, but I know of no other writings that cover the matter more fully.

Dr. Hardy stated that he approves of reproducing in a denture the types of deformity that occur in the recent natural teeth of the patient. The anterior teeth in such cases are found elongated in posture and are erupted in torsion. To reproduce these deformities appears to be unwise, in prosthesis, for the reason that deformity anywhere in the body reduces ability to function. It is my practice not to reproduce deformities of this character, but rather to modify them in such a way that the facial characteristics remain, while the function is improved. Full dentures are made, in nearly all instances, because the teeth have been lost through disease. The position of such teeth in the mouth is indicative of the state of their health. Disease is never pleasing to the eye, and it is not good esthetics to reproduce the posture of body infirmities. Rather would I attempt so to modify the form and color of the porcelain substitutes that they would appeal to the eye as having health. Not all mouths are endowed by nature with lines of perfection as regards the alignment of the teeth, for body symmetry of line and form is only occasionally observed in the natural healthy mouth. These departures from the ideal may be successfully employed in setting up porcelain teeth, and possibly our essayist has this thought in mind.

Dr. Hardy has made a good suggestion regarding the replacement of extracted teeth in an impression, as a first step in denture work. His use of modeling compound for this purpose has been superseded, in my practice, by yellow beeswax, which sets as does compound; and when chilled has the necessary hardness, and also certain plastic properties, that make it much easier to replace the teeth in correct assembly. I mention this matter to emphasize in a practical way a very desirable thought in, rather than to detract from the value of, Dr. Hardy's excellent paper.

It has been many years since I ornamented any of my dentures with gold to simulate a filling. Time was when this practice was very general, and I

confess to having employed this absurdity in an attempt to make my dentures look more like the late lamented originals. Only recently I prepared cavities in the central incisors of a contemplated set of teeth, to appease the whims or notions of a lady who insisted upon gold fillings in these teeth. Instead of inserting gold, in this instance, following the modern trend, I employed instead the much berated synthetic porcelain, telling my patient that I would later relieve her of her new denture for the purpose of inserting the gold, praying fervently all the time that it might not be necessary. And it was not, for when the "family" had had the usual "pow wow" over my esthetic endeavors, they decided for their mother that porcelain was "much more stylish" and that she must take the porcelain instead of the gold. It was newer.

I now quote from the last paragraph of Dr. Hardy's paper, as follows: "It is the writer's belief that dentures constructed without constant attention to proper esthetic values even though they function properly, are never a source of great satisfaction to the wearer, and do not reflect very much credit on the practitioner who made them." His thought is well said. But had I written the remark, I would have stated also that it is never enough to please one's patient in full-denture prosthesis. For esthetics in this work is a matter that may properly be brought before not only the family circle but also the bridge club and sewing society, if any.

Edward Kennedy, D.D.S. (New York City): I do not feel that I can add anything from a technical standpoint. I must compliment Dr. Essig and Dr. Hardy on the way they have handled this subject from a practical standpoint, and have not ridden a hobby. I cannot altogether agree with Dr. Essig, but I have too much respect for his ability as a prosthetician to question his technique. A great many of the points he has brought out are very well taken. Dr. Hardy has called to our attention something that a great many neglect; that is, the really artistic arrangement of the teeth. His method of procedure is very practical. Dr. Tench also emphasized the fact that many patients are referred to the prosthetic specialist *after* the teeth are extracted rather than before, and he then has neither records nor any conception of the patient's looks before the teeth were extracted. I want to suggest to all dentists that it is quite a simple matter to make records of the mouth before teeth are extracted, without taking full impressions. It is only necessary to cut a piece of pewter or air-chamber metal into an oval shape to about cover the anterior teeth, cover this with modeling compound, and press it against the labial surface of the teeth. Two of these are made: one for reproducing in plaster; in the other, the extracted teeth

are placed and covered with plaster. This makes a permanent record, easy to store away, and of the greatest assistance in reproducing the esthetics.

On one point I disagree with Dr. Essig. I understood him to say that he did not use clasps in lower partial-dentures. I have tried this, but it always ended in disaster. I believe more injury is done to the adjacent teeth by this method than if a light-wire clasp, properly designed, such as the Gillett clasp, were placed on the denture in the first place.

E. J. Van den Berg, D.D.S. (Amsterdam, Holland): I would like very much to compliment and pay my respects to Dr. Hardy on his excellent presentation. Dr. Hardy showed us how to make a plate so that it is pleasing in appearance and an asset to the facial expression of the patient. In Europe (especially in Holland, where the country is so small that you have to ride only two hours by train to be in another country) there are other things that require consideration, if you want a plate to give the highest degree of service. I refer especially to the different languages. This phonetic point is very important. In America you have one language, but in Holland there are many—German, French, English, and several others. It is absolutely necessary, if one is to use anterior teeth on a plate, to make the lingual surface like that on the natural teeth. If you do not have the teeth and the vulcanite, or other material you use, exactly like the natural teeth, so that a close approximation is made, the result will be unsatisfactory. If you have to make a plate for a singer or speaker, these problems must be considered in order to get the best results in enunciation. We must therefore consider the phonetical problems and the different languages, and how the point of the tongue articulates in each language.

Dr. Essig: I have often thought, in listening to papers, that discussion is a question of personal equation, of experience, of just what each man becomes accustomed to doing and how he does it. I think that any one who has gone far into the subject of artificial dentures has entered it as a specialty. He does a great many things that he cannot impart to others. He does a great many things, and gets a great many results, that can only be obtained by years of constant concentration on that particular department of prosthesis. I remember very distinctly, to make my meaning clear, a young English woman who was sent to me after she had had all her teeth removed. She was quite a pretty girl, who, after an unfortunate life, had been reduced in circumstances. She was sent to me by a lawyer who asked me to do this work as an act of charity. She had been in this country about two years. The first question I asked her, after carefully examining her countenance,

was: "Have you a photograph?" She said she had. You know just about how useful the ordinary photograph is to the prosthetist in re-establishing a natural condition of affairs. However, I took the case in hand and saw, by the general formation of her mouth, that she must have had overlapping centrals, an exceedingly narrow arch—an arch such as is found in mouths of thumb-sucking children or children with adenoids, the high-vaulted arch. At any rate, I reproduced the teeth. It was about the time I had finished carving the Park teeth. I was able to reproduce the lingual surfaces as well as the labial, and to keep the rubber very thin. She expressed herself as being very much pleased and satisfied. She was then employed as a tutor or governess to one of my patients. The woman came in and complimented me on the way I had reproduced the mouth. I thought, of course, that anything would look well after the girl had been going around with an edentulous mouth. However, she went home to her family in England and stayed there about seven or eight months, and came back to me to have some changes made in the denture. I said to her, as I knew it would be the crucial test: "What did your parents say of the dentures?" She replied: "They haven't noticed them yet." That was the greatest praise she could have given me. Another case referred to me was a governess, who also was put in my hands as a charity patient. I knew that she came from the north of Ireland. I am rather familiar with the peculiar dental irregularities that are common in certain districts in Ireland. I reproduced her mouth, never having seen anything but her lower teeth, a few of which remained. When she came back for adjustment, she said: "My sister asked me how you knew what my teeth looked like."

Regarding the point Dr. Tench brought up about the final adjustment in the mouth: I have found that I get greater comfort, greater ease of motion, greater equal balance, or a more equally balanced pair of dentures, or an equally balanced partial denture, if I make my final adjustments in the mouth. That does not mean, however, that just as good adjustment could not be attained in another way. Dr. Tench does just as good work as I do, but he may do it in different ways. My effort has been, for a great many years, to teach the fundamentals—the things we cannot be without, which are as important to dentistry as the foundation of a house.

Dr. Hardy (in conclusion): I want to thank Dr. Collins for the suggestions he has given me, particularly that of taking the impression of the natural teeth in beeswax, a simple thing that never occurred to me before. I have experienced, as he suggested, some difficulty—in fact a great deal of difficulty, sometimes—in getting the natural teeth in just the right position in

the modeling compound. Therefore, I want to pay tribute to him for that suggestion, which I shall proceed at once to adapt to my uses.

He suggested the inadvisability of imitating certain irregularities that would interfere with the balanced occlusion. I think I answered that point to some extent when I illustrated, on the screen, the position of the two central incisors in the mouth of the young man with the lateral incisors in a posterior position. I mentioned then that, in his natural teeth, the bite was locked, but in the artificial teeth, while we took pains to create a similar impression as regards appearance, we also took great pains not to lock the bite so as to leave plenty of room for his lateral excursion and thus were able to give him a finished denture. As Dr. Collins stated, the facts of esthetics cannot be properly explained, but must be seen to be fully comprehended.

THE LABORATORY DIAGNOSIS OF VINCENT'S INFECTION

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I. INTRODUCTION

During the last five years a marked increase in the number of cases of Vincent's infection has been noted by both dentists and physicians. It seems strange, as one compares this infection with other communicable diseases, that little more is known of its etiology than when first described by Plaut in 1894 and Vincent in 1896. Spirochetes, fusiform bacilli, and cocci, are always present in smears, but this is also true of smears from many normal mouths and from mouths showing other pathological conditions. The number of species of spirochetes, and the marked pleomorphism of the fusiform bacillus always associated with them, raises the question as to what constitutes a positive laboratory diagnosis. In other words, when is a smear to be considered positive for Vincent's infection and when negative?

On the basis of our present knowledge the diagnosis of Vincent's infection has not been reducible to a routine laboratory determination. Most pathogenic organisms that occur in routine work are isolated and cultivated with relative ease; they represent definite morphological types whose etiological relation to disease has been repeatedly proven. In contrast, there are present in the mouth four or more species of spirochetes, all of which are morphologically difficult to recognize in stained smears. They stain poorly with the ordinary

[1] A portion of this paper represents work carried out by Mr. Curley in partial fulfillment of the requirements for the degree of Bachelor of Science at this College.

aniline dyes, and the spirils are greatly distorted even in smears carefully stained by Giemsa's method. As Beckwith (1925) has suggested, these mouth spirochetes are best observed under the darkfield microscope. Three of the species, *Treponema microdentium*, *T. macrodentium*, *and T. mucosum* are all characterized by their regular corkscrew-like appearance and motion. None of these species are more than 12 microns in length. *Treponema vincenti*, which is probably identical with *Spirilla sputigenum*, is quite distinct. It varies in size from 7 to 25 microns, and moves with an irregular, snake-like motion. Tunnicliff (1923) considers *Fusiformis dentium* and the spirochete (*T. vincenti*) most commonly associated with Vincent's infection to be pleomorphic forms of a single species. Neither Pratt (1927) nor Varney (1927) agree with this view. Both have successfully cultivated the fusiform bacillus in sufficient numbers for serological tests. At no time did they find spirochetes in their cultures. Varney regards the fusiform bacilli as a heterogeneous group that may be subdivided into four subgroups differing from each other serologically and culturally.

In smears from the mouth the fusiform bacillus varies in morphology from fine threadlike forms to thick crescents. In a study of more than two hundred direct smears from clinical cases of Vincent's stomatitis, we have been able to recognize two of Varney's types: the narrow filamentous and broad stubby forms. In egg-broth medium, covered with a mixture of paraffine and vaseline, we obtained almost 100 per cent positive cultures of *Fusiformis dentium* associated with the various cocci. The medium should be boiled, and allowed to cool before inoculating, in order to drive out all traces of oxygen. The isolation of the oganism in pure culture is difficult. Pure stock cultures grow well upon ascitic or serum agar under anaerobic conditions. The slightest change in the pH value of the medium was found to affect the growth and form of the bacillus. From the observed results in vitro it seems entirely possible that changes in the alkalinity or acidity of the mouth may induce similar variations of marked character in the form of the organism as found there.

Brams and Pilot (1923) found fusiform bacilli in 82 per cent of normal tonsils; Pratt (1927) found them without exception in two hundred normal mouths. Our own findings show that they are almost

always present in normal mouths. Personal inquiry has developed the fact that there is considerable difference of opinion among some of the leading bacteriologists as to the number and species of organisms in smears considered positive for Vincent's infection. These opinions varied from that of the necessity of finding both spirochetes and fusiform bacilli in great numbers, to one requiring the presence of only a few fusiform bacilli. A review of the literature proved equally unsatisfactory.

In studying smears from clinical cases of Vincent's stomatitis, it was soon found that there was a marked difference in the flora in various parts of the mouth. Thus, smears taken from the gingival margin of either the upper or lower anterior teeth showed a predominance of cocci, short thick crescent-shaped fusiform bacilli, and *Treponema microdentium* and T. *macrodentium*. The larger irregularly waved *Treponema vincenti* is rarely present in such smears. In contrast, smears from deep necrotic pockets in the posterior, or between the anterior teeth, show few cocci, a few large fusiform bacilli, and a great predominance of *Treponema vincenti*. The other mouth spirochetes are usually few in number. This difference is undoubtedly due to oxygen supply, *T. vincenti* being a very strict anaerobe that can survive only in the absence of oxygen. In one case a smear taken from a deep necrotic pocket, on the lingual side of the upper molar, showed by direct count, in ten fields under oil immersion, 370 *Treponema vincenti*, 74 fusiform bacilli, and 101 cocci, the spirochetes having been by far the predominating organisms. The following case also illustrates this predominance of spirochetes in deep necrotic pockets:

J. F. presented at dental clinic, Oct. 26, 1929. He was advised to have full set of x-rays, which showed upper right first bicuspid and lower left second bicuspid abcessed; upper left second bicuspid dead. Three teeth were extracted 10:28:29—upper right first bicuspid, upper left second bicuspid, lower left second bicuspid. To extract upper left second bicuspid it was necessary to remove a bridge, exposing inflamed necrotic area upon which bridge pontic had pressed. This area was not visible while bridge was in place. Examination revealed pocket, approximately one-fourth inch in depth, filled with gray necrotic tissue and pus. Smear taken from deepest part of pocket showed great numbers of large *Treponema vincenti*, and occasional large granular fusiform bacillus. No cocci were at first

noticed in smear, but later careful study revealed approximately same number of cocci as fusiform bacilli. Anaerobic cultures showed few colonies of fusiform bacilli and micrococci. Patient received treatment for Vincent's. Smears taken one week later were negative for spirochetes and fusiform bacilli. At this time, pocket was filling in with granulation tissue.

In our experience smears from cases of only two or three days' duration also show a predominance of *Treponema vincenti*, cocci and fusiform bacilli increasing as the case progresses and tissue sloughs. We have not found *T. vincenti* present in smears from mouths having no abnormal gum tissue. It has however frequently been found in other inflammatory conditions that may represent chronic-carrier stages of the disease. We therefore consider our laboratory diagnosis of Vincent's infection positive only when *Treponema vincenti* is present as the predominating organism in smears from deep necrotic pockets. Noguchi (1912) isolated *Treponema microdentium*, *T. macrodentium*, and *T. mucosum* in pure cultures. None of these three were found by him to be pathogenic when injected intratesticularly into rabbits. In our laboratory we have occasionally obtained good cultures of *Treponema microdentium* with bacteria in Hogue's (1922) ovimucoid medium and in Broeck's (1925) Locke-egg-albumen medium, when incubated under anaerobic conditions. Occasionally we have found a few *Treponema vincenti* in egg-broth medium, at the end of 24-hour incubation, but apparently they are merely survivals, as none were ever found in second transplants. Noguchi (1928) stated that he was unable to obtain a growth of this species. We have made no attempt thus far to isolate any of the mouth spirochetes in pure culture.

The infectious nature of the disease is recognized by all who come in contact with it. Smith (1930) reported a case of Vincent's angina and a pulmonary spirochetosis in physicians after contact with cases of Vincent's angina. Several cases of Vincent's stomatitis have developed with us in dental students who had treated cases of the disease in the dental clinic.

Thus far no one has reported the production of experimental Vincent's stomatitis in animals. Weaver and Tunnicliff (1905), injecting mixed cultures containing fusiform bacilli into the leg of a guinea pig, produced small abscesses. Later Tunnicliff (1911) isolated three strains of fusiform bacilli in pure culture, which she injected intra-

peritoneally, intravenously, and into the mucous membrane of the mouth in a number of laboratory animals, but with negative results. The greatest number of experiments were carried out by Kline (1923), who produced experimental gangrene necrosis in forty guinea pigs and rabbits. Duplicate injections of material, from cases of Vincent's infection containing spirochetes, fusiform bacilli, and cocci, were made into the two hind-quarters of guinea pigs. One side of each animal was traumatized by bruising with a hemostat, while the other side was not injured. Injections made into the traumatized tissue abscessed, while those in normal tissue gave negative results or produced only small abscesses. Smith has also produced infections by injecting rabbits intratracheally with sputum from a case of pulmonary spirochetosis containing spirochetes and fusiform bacilli.

II. EXPERIMENTS

In our own attempts to produce experimental Vincent's stomatitis, kittens were placed on a diet composed of oat-meal mush, condensed milk, white bread, and water. This diet was planned to cause experimental scurvy, thus lowering the tone of the gum tissue. Either cultures or mixtures of organisms from untreated cases of Vincent's infection were used. In some cases the organisms were merely rubbed on the uninjured gum tissue. In other experiments the gums were scarified with sand-paper discs. In our later work the gingiva were separated from the necks of the teeth by inserting a small Wedelstaedt chisel, which was drawn back and forth several times, making a pocket several millimeters deep. In two animals experimental pockets were made in the interproximal space between the upper left canine and premolar, to a depth of 6–7 mm. by means of a large round bur in a dental engine. Inoculations, from an acute case of Vincent's stomatitis, were made directly into the pockets. In one animal the pocket was left uncovered; in the other, the inoculated pocket was partially covered with a crown having a large gingival overhang. A crown constructed with a saw-tooth edge and gingival overhang was placed on the upper left canine of a third animal. A week later organisms from an acute case of Vincent's stomatitis were inoculated into the inflamed and lacerated gingival tissue. Before inoculation, the mouths of all kittens were examined for spirochetes or fusiform bacilli. None

were found in any of the animals. A filamentous, branching, gram-positive organism, undoubtedly *Actinomyces*, was the predominating form in all the smears. The data of the experiments are shown in the accompanying table, where it may be seen that only the inoculation

TABLE 1

Inoculations for the production of experimental Vincent's stomatitis in kittens

EXPERIMENT NUMBER	SITE OF INOCULATION	MATERIAL INOCULATED	RESULT OF EXAMINATION BY DIRECT SMEAR EVERY SECOND DAY FOR 8 DAYS
1	Surface of gingiva	Pure culture of *Fusiformis dentium*	Negative
2	Scratched surface of gingiva	Pure culture of *Fusiformis dentium*	Negative
3	Scratched surface of gingiva	Mixed culture of *Fusiformis* and cocci	Negative
4	Injection into gingiva with small Luer syringe	Organisms in Martin's broth from acute case of Vincent's stomatitis	Negative
5	Surface of gingiva	Organisms direct from acute case of Vincent's stomatitis	Negative
6	Scratched surface of gingiva	Organisms direct from acute case of Vincent's stomatitis	Negative
7	Pocket at neck of tooth	Organisms direct from acute case of Vincent's stomatitis	Negative
8	Deep pocket in bone between canine and premolar teeth	Organisms direct from acute case of Vincent's stomatitis	First smear positive for spirochetes. Remaining smears negative
9	Gingival tissue beneath overhanging crown	Organisms direct from acute case of Vincent's stomatitis	Negative
10	Lacerated tissue beneath crown	Organisms direct from acute case of Vincent's stomatitis	Negative

made into the deep pocket (Exp. 8) gave the slightest indication of a persistence of Vincent's organisms. The gums were always pink and healthy in all the kittens. Scratched or lacerated surfaces healed quickly.

It is quite possible, of course, that cats have a species immunity to

the organisms productive of Vincent's infection, thus accounting for the fact that although microörganisms from acute human cases were brought directly into contact with lacerated oral tissues, no infections resulted.

III. SUMMARY

1. In Vincent's infection, and other pathological conditions of the mouth, direct smears contained several species of spirochetes, fusiform bacilli, and cocci.

2. The relative numbers of each of these organisms varied in smears from different parts of the mouth. Along the gingiva and in chronic cases of Vincent's infection, cocci, and thick crescent-shaped fusiform bacilli predominated. In acute Vincent's infection, and in deep necrotic pockets, the predominating organism was *Treponema vincenti*.

3. We consider our laboratory diagnosis of Vincent's infection positive only when *Treponema vincenti* is found as the predominating organism.

4. Attempts to produce experimental Vincent's stomatitis in kittens were unsuccessful, possibly because of a species immunity to the organisms productive of this disease.

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A TEAR IN THE CEMENTUM

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Two years ago, Figg[1] reported a case of tear in the cementum, and submitted it as evidence that the connection between the dentine and

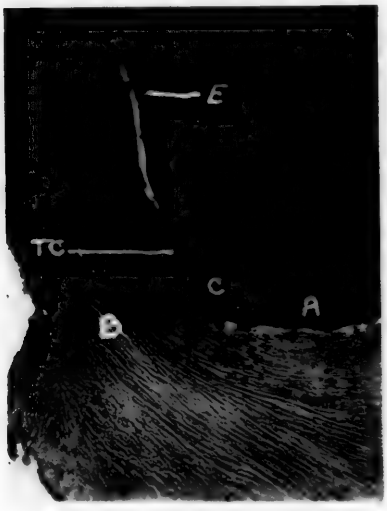

FIG. 1

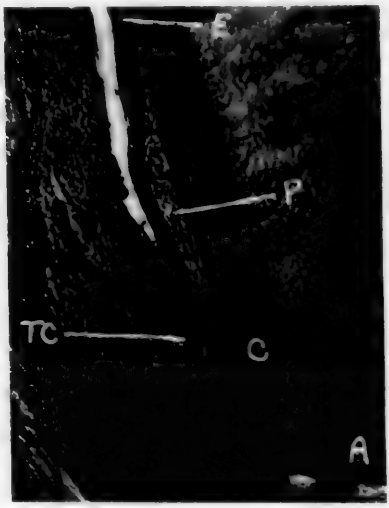

FIG. 2

FIG. 1. CROSS SECTION OF A PORTION OF THE ROOT OF A HUMAN UPPER LATERAL INCISOR TOOTH UPON WHICH RESECTION HAD BEEN PERFORMED

A, cut surface of the root. *B*, fibres of peridental membrane blending with granulomatous tissue. *C*, old cementum. *TC*, torn cementum, with normal peridental tissue occupying space caused by tear. *E*, torn cementum attached to old cementum.

FIG. 2. ENLARGEMENT OF A PART OF FIG. 1

A, cut surface of root. *C*, old cementum. *TC*, torn cementum. *P*, peridental tissue occupying space caused by tear. *E*, torn cementum attached to old cementum.

cementum is stronger than that between the lamellae of the cementum itself. The case reported below is interesting in that it is from human

[1] Figg: *Journal of Dental Research*, 1928, viii, p. 623.

material, with a known history of trauma, and one end of the tear is still in connection with the old cementum. This specimen was found during an examination of sections of a tooth upon which resection had been performed.

In *fig. 1*, *A* represents the cut surface of the root. At *B*, the fibres of the peridental membrane blend with the granulomatous tissue that covered the resected root. At *C* old cementum is visible; at *TC* may be seen torn cementum, with normal peridental tissue occupying the space caused by the tear; at *E* torn cementum remained attached to

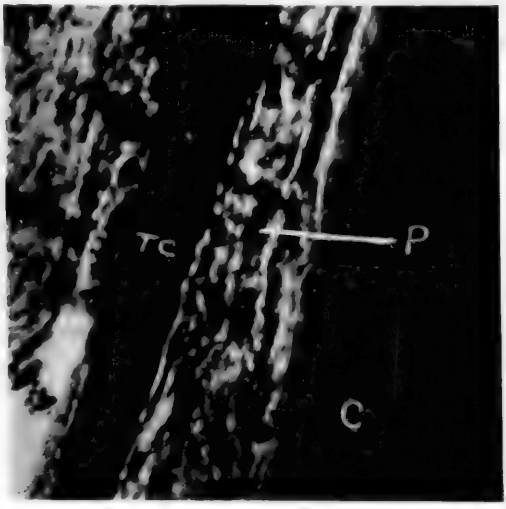

FIG. 3. ENLARGEMENT OF A PART OF FIG. 2

C, old cementum. *TC*, torn cementum. *P*, peridental tissue occupying space caused by tear.

old cementum. In *fig. 2*, *A* represents the cut surface of the root; *C*, old cementum; *TC*, torn cementum; *P*, peridental tissue occupying the space caused by the tear; *E*, torn cementum attached to old cementum. In *fig. 3*, at *C* may be seen old cementum; at *TC*, torn cementum; at *P*, peridental tissue occupying the space caused by the tear.

In this case it is evident that the cementum was torn while the resection was being performed. In view of the fact that the splinter was partially detached from the cementum, we conclude, as does Figg for his case, that the connection between cementum and dentine is stronger than that of the lamellae of cementum itself.

AN EXPERIMENTAL STUDY OF THE GROWTH EFFECTS OF THE ANTERIOR LOBE OF THE HYPOPHYSIS ON THE TEETH AND OTHER TISSUES AND ORGANS[1]

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I. INTRODUCTION[2]

Clinical literature abounds with references to variations in the dentition and to dental anomalies as the result of pituitary changes. Among such references are those of Kaplan (95), Howard (86), Graves (68), Kranz (101), Petzel (136), Ward (192), Cedercreutz (23), Englebach and Tierney (44), Stener (171), and others, all of them accepting in varying degrees the hypothesis that such a direct connection exists. In many cases this has been reported as sufficiently clear-cut to be pathognomonic of pituitary dyscrasias. A diligent search of the literature fails to reveal experimental studies of a careful nature pointing in this direction, although such a relationship has been experimentally demonstrated as existing between the parathyroids and the dentition. Among these studies in particular are those of Erdheim (45,46), Gies (63,64,65), Toyofuku (186), Hammett (71), and Toverud

[1] Presented to the Graduate School of the University of Pennsylvania in partial fulfillment of the requirements for the Degree of Ph.D. in Medical Science, June, 1930.

[2] The earlier portions of the experimental work involved here were done in the laboratories of the Department of Anatomy of the University of Pennsylvania. The director of this department, Dr. Eliot R. Clark, was Chairman of the Committee to which this thesis was presented.

(185), in all of which adequate evidence is presented that the texture, tensile strength, and the tissues surrounding the teeth respond to parathyroid change. In addition to these, many studies including those of Blum and Mellion (18), Cohen and Mendel (26), Höjer and Westin (79), Westin (196, 197), Howe (84, 85), Jackson (88, 89), Jones and Simonton (93), Karshan (96), Marshall (112, 113), McCollum, Simmonds, Kinney and Grieves (109), Mellanby (117, 118, 119), Meyer and McCormick (121, 122), Robb, Medes, McClendon, Graham, and Murphy (148), Erma Smith (160), Wolbach and Howe (201–204), Zilva and Wells (205), and Toverud (186), to name only a few of a very considerable number, have been made upon the effects of diet on the development and later pathology of the teeth and investing structures. Further than this many studies have been made upon the relationship of the growth hormones of the anterior lobe to metabolism. By consolidating the results of these various types of studies it becomes rather apparent that the hypophysis directly affects metabolism, and that metabolic changes are very apt to be reflected in the dentition.[3] My own earlier studies (35–38) gave sufficient reason for believing that there might be a connection between hypophysis and dentition, although not exercised in the direction of specific anomalies. Having in mind all of this background, pointing to the possibility of effects of the growth hormone in the anterior lobe on the development and pathology of the teeth and investing structures, the present study was begun.

In the experiments basic and preliminary to those herein described, a wide variety of methods was attempted and the results analyzed. Both homeo- and heterotransplants were utilized with about equal results, but were discarded because of the growing evidence, as presented by P. E. Smith, Engle (165, 167), Evans and Simpson (54), and others, that the anterior lobe elaborates at least two and possibly more hormones, only one of which apparently has a very direct bearing on the problem of growth. Various extracts containing the growth hormone were tried, but were discarded in favor of that described by Evans in his Harvey Lecture (47), and later (53, 54) somewhat modi-

[3] Studies in the direction of an effect of the hypophysis on "basal metabolism" have been largely negative. It is not felt, however, that O and CO_2 exchange necessarily constitute an indication of the fundamental metabolism of the organism.

fied by him and his associates. This extract gave the most consistently good results and, after an optimum dosage was obtained, seemed to have the fewest complicating features. Ablations and hypophysectomies were done on rats, mice and dogs, but were abandoned because of the very numerous complications involved—excepting those on dogs, in which the transbuccal complete hypophysectomy, as described by McLean (110) and somewhat modified to apply to younger and smaller animals, while attended by numerous difficulties, was found to be quite satisfactory and was utilized for the dog experiments.

The data in the ensuing study, upon which the curves for both normal and hypophysis-stimulated growth in mice are based, relate to controlled injection experiments begun in the fall of 1927. Since that time thirty-eight experiments have been conducted on animals from this stock at different seasonal periods and under somewhat varied environmental conditions, utilizing a total of nearly four thousand animals, over one half of which were treated in various ways by pituitary medication. The normal growth-curves for this stock, under a wide variety of conditions of handling, show remarkably little variation; and the later injection-stimulated curves, where a similar dosage (the optimum one) was utilized, likewise show little variation. Thus while quite numerous earlier experiments have laid the ground-work for and pointed the direction to the present enquiry, these consist of two complete series of studies: one, controlled injection experiments on mice; the other, hypophysectomy and injection experiments upon dogs. It was considered wise to utilize the two types of animals because of the fact that the one, mouse, permitted studies upon large numbers of animals throughout their entire lifetimes, as well as upon a continuously growing dentition and the cell changes and the chemical reactions at different periods; while the other, dog, permitted the simulation of both hypo- and hyper-secretions, and cell studies of larger structures and on a form having both deciduous and permanent dentitions not too far removed from the human type. For purposes of clarity, references to and comparisons with the literature have not been used in the parts of the paper (II and III) dealing with the experimental work proper, but have been reserved for a separate section (IV).

It is a pleasure to acknowledge my very great indebtedness to a

number of persons who have in large part made this work possible, particularly to Miss Katherine Cary and Miss Lucille Reed for assistance in the chemical analyses; Miss Anna E. Wilson and Miss Angelina Collins for secretarial assistance, and Drs. J. P. Peters, Raymond G. Hussey, H. S. Burr, Daniel C. Darrow, and Sophie B. de Aberle for aid in interpreting findings; Drs. E. M. K. Geiling, E. A. Sharp and C. C. Little, for assistance in obtaining materials; and Dr. W. S. German for assistance and guidance in the surgical technic involved; as well as the members of my graduate committee, whose courtesy and forbearance is truly unforgettable. To many others, to whom I am directly and indirectly indebted, I can only express my thanks in a general way, the list being too great to enumerate individually.

II. STUDIES ON MICE

The animals used in the following series of experiments were from the stock of "dilute browns," in Dr. C. C. Little's colony for the Department of Mammalian Genetics of the University of Michigan, at Ann Arbor. Since having been taken from that colony they were very closely inbred—for the most part, brother-to-sister matings. For these studies, the animals were separated into male and female groups, in order to avoid the variations due to breeding. When used in the tests, those of given litters were distributed as nearly as possible equally into the different groups. For this particular study, 192 animals were used—96 males, 96 females. All were twenty-one days old at the beginning of the experiment. It may be readily seen that, in order to obtain such a number, it had been necessary to plan a considerable time ahead, and mate a large number of animals at the same time in order to have offspring of the correct age and number.

The groups of 96 of each sex were divided into sub-groups of 48. One of these sub-groups in each case was to be treated, the other utilized as untreated control animals. Previous studies had demonstrated that there was no advantage in injecting the control animals, either with some other type of extract, such as that prepared from liver, or with normal saline. Using the controls as purely untreated animals simplified the procedure. At the initiation of the studies, each treated animal received 0.05 cc. of the alkaline growth extract of

the anterior lobe twice daily at equal intervals.[4] Otherwise all of these animals were handled in a similar manner; their diet was uniform, and the cleaning and changing of cages, and the other environmental conditions, were made as nearly identical as possible. When the animals had reached the age of six weeks, the dosage was increased to 0.1 cc.

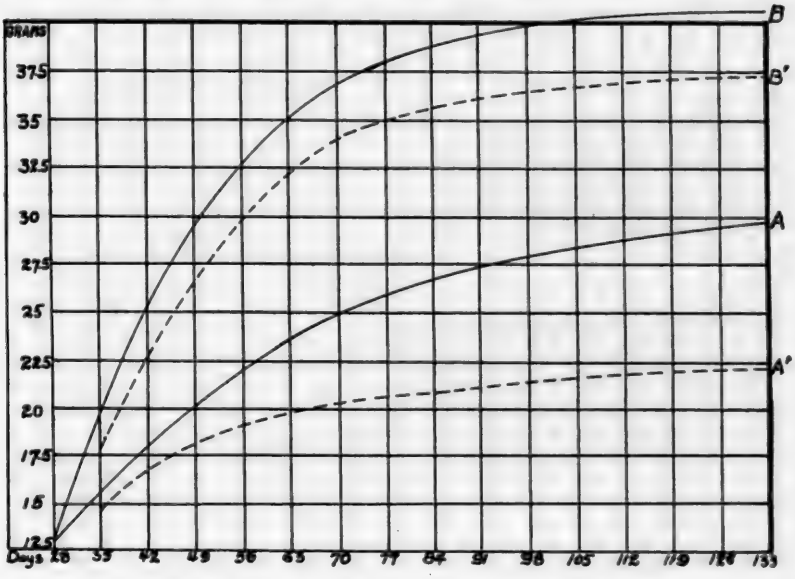

FIG. 1. GRAPH SHOWING GROWTH CURVES OF TREATED AND CONTROL MICE

A—Normal, untreated control animals. *A*[1]—Same; data computed on a fat-free basis at all levels. *B*—Alkaline-injected animals. *B*[1]—Same; data computed on a fat-free basis, after the method of Moulton.

twice daily, as earlier experiments had indicated that this was the optimum dosage. At the beginning of the experiments, two animals from each of the four sub-groups were killed and analyzed chemically. For four successive weeks this was done at weekly intervals, and then the interval was increased to two weeks. When animals were killed for

[4] This extract was prepared by Dr. E. M. K. Geiling of the Department of Pharmacology, Johns Hopkins Medical School, according to the formula outlined by H. M. Evans in his Harvey Lecture of 1923–1924, except that the pH was maintained at probably a slightly higher level than that of Dr. Evans' original extract. Our studies had indicated the desirability of this change.

analysis, all in the various sub-groups were weighed carefully and an average obtained for each sub-group, upon which is based the stimulated-growth curve shown in *fig. 1*. The associated normal-growth curve was obtained from average data for different periods and environmental conditions in a large number of studies, but it agrees so closely with the normal-growth curve for the series of control animals in this group of studies that they may be accepted as identical.

FIG. 2. TOP: UNTREATED CONTROL FEMALE MOUSE; TWELVE WEEKS OF AGE. BOTTOM: LITTER-MATE FEMALE; RECEIVED INJECTIONS OF THE ALKALINE PITUITARY EXTRACT TWICE DAILY

Chemical studies

As the animals were killed, those of a similar type of treatment and handling were frozen with "dry ice" until quite hard, and then ground separately in a food chopper with the finest cutter in place. This material was thoroughly mixed and ground again, and the process repeated six times until it was believed that the mass was thoroughly homogeneous. These thoroughly mixed masses of fresh whole-mouse tissue were then utilized for the chemical analyses. Approximately 5 gm. of each mass were taken for a determination of total nitrogen—Kjeldahl's were run on each in duplicate. Approximately the same amount was used for a determination of total fat content as indicated

below. The remainder[5] was dehydrated in an electric incubator at 110°C. for eight days and the loss of weight computed as water. This dried tissue was ashed in an electric muffle for twelve hours at a temperature of about 1400°F., and the percentage content of ash computed. The fat analyses were made by the method of Hertwig, Jamieson, Baughman, and Bailey (78), which is a modification of the Kerr-Sorber method. About 5 gm. of the material were put into a

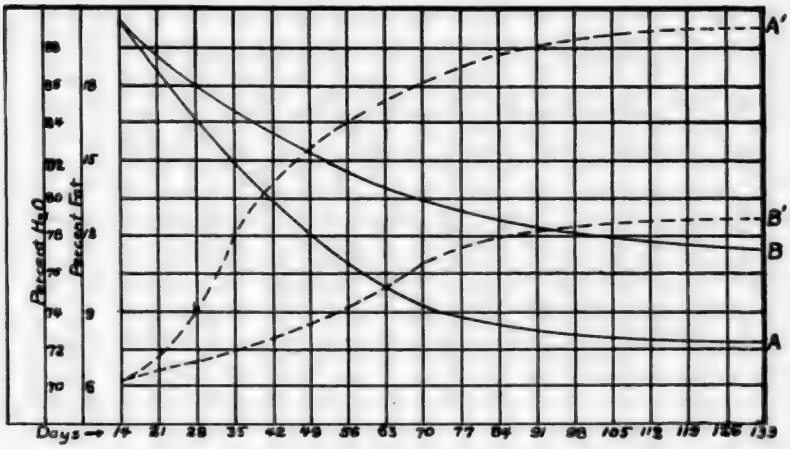

FIG. 3. GRAPH OF WATER AND FAT CONTENT OF FRESH WHOLE-MOUSE TISSUES AT ALL AGE LEVELS

A—Water content of tissues of control animals *A*[1]—Fat content of same tissues. *B*—Water content of tissues of injected mice. *B*[1]—Fat content of same tissues.

250 cc. Erlenmeyer flask, to which was added 60 cc. of alcohol and 6 cc. of KOH solution (100 gm. of KOH in 100 gm. of distilled water). A funnel was placed in the neck of the flask and the contents boiled gently on a steam bath for twenty minutes, or until saponification was complete. This mass after cooling was acidified with concentrated HCl and poured quantitatively into a separatory funnel. The fatty acids were shaken out with ether, using three successive portions of not less than 100 cc. each. The HCl in the ether solution was washed out

[5] Micro-chemical determinations of calcium and potassium, in the tissues of the last two series of animals, were made to ascertain whether the balance between these two had perhaps been altered. Such was not found to be the case.

with distilled water. The ether solution was considered free from HCl when the wash-water no longer showed a pink tint with methyl-orange. The ether solution of fatty acids was dehydrated over anhydrous sodium sulphate, centrifuged free from the salt, the ether evaporated, and the residue dried to a constant weight of 80°C.

This type of handling and computation was continued over a total period of sixteen weeks. The accompanying graphs (*figs. 3* and *4*) were prepared from the data so obtained. In the chemical analysis it was found that the tissues of the pair of animals from each sub-group, handled separately throughout as stated above, were so nearly the

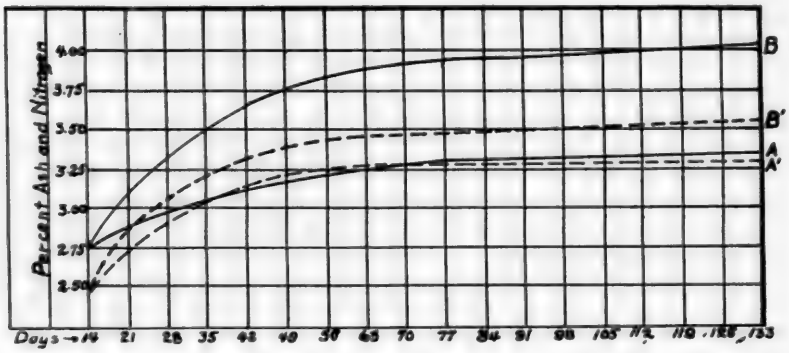

FIG. 4. GRAPH SHOWING TOTAL ASH AND TOTAL NITROGEN CONTENTS OF FRESH WHOLE-MOUSE TISSUES AT ALL AGE LEVELS

A—Total ash content of fresh whole-mouse tissue obtained from untreated control animals. A^1—Total nitrogen content of tissues of same animals. *B*—Total ash contents of tissue from alkaline-injected animals. B^1—Total nitrogen content of same tissues.

same, irrespective of sex, that the data were grouped simply into experimental and control series. In addition to the chemical studies outlined above, and at irregular periods extending over the entire experiment, animals representative of each experimental group were killed and autopsied, and sections made of the more important visceral organs and of the maxillae and teeth.

Findings. The accompanying graphs (*figs. 3* and *4*) show that the animals receiving the alkaline anterior-pituitary extract grew at a markedly more rapid rate, and to a considerably larger size, than the untreated control animals (*figs. 1* and *2*). This difference apparently

had no relationship to the sex of the animals, although with increasing age each sub-group gradually lost in water-content, which remained considerably higher at all levels in the alkaline-injected animals than in the uninjected controls at the same levels (*fig. 3*). The injected animals did not take up or show nearly as high a proportion of fat as the uninjected controls. Each type of animal, with advancing age, showed a tendency to increase gradually the total mineral content of the tissues. This was, however, considerably more evident in the injected animals than in the controls (*fig. 4*).

Moulton (127) has shown that in order to compare data such as these it is necessary to make the computations on a fat-free basis. For that reason the data were computed on this basis as well as on that of the whole-tissue. While this method naturally varied the percentages shown, the relationship between the contents of injected and control animals was not materially altered. As animals of each type aged, the total nitrogen in the tissue tended to increase. While this was apparently more true of the alkaline-injected animals than of the controls, the very slight difference was considered as being well within the margin of error for such computations.

Inasmuch as various methods of preparation of the growth-hormone extracts have been used by different workers, several of these were tried as a check. Thirty-four animals of an average weight of 12 gm. were divided into four nearly equal groups, and the sexes kept segregated. The animals in one group received injections of Evans alkaline extract as prepared for me by Dr. Geiling; one, the Teel "globulin" fraction, also prepared in Dr. Geiling's laboratory; and one the Parke-Davis product—0.1 cc. twice daily in each case. Each product resulted in a stimulation of growth, which was most for the Teel "globulin" fraction, and least for the Evans extract prepared by Dr. Geiling. There was a notable difference between the effects of the "globulin" fraction and the other two, but much less difference between the effects of the Evans extracts as prepared by Parke-Davis and by Dr. Geiling.

An effort was made to apply the method of Marshall by injecting trypan blue or naphthalene brilliant blue, or one of the alizarin dyes, to obtain definite lines of deposition of calcium in the teeth and thus show the rate of growth. However, the outcome was not satisfactory, and no conclusions may be drawn from this portion of the study.

But the method of marking the constantly growing incisors with a fine thin disk on a dental mount, and marking again at regular intervals, thus recording differences in rate of growth in these teeth, was fairly satisfactory. By this method it was found that the incisor teeth of injected animals showed a more rapid growth than those in control animals. In this series it was determined that the average rate of

TABLE 1

Data showing the growth rates of mouse incisors; expressed in millimeters

ANIMALS*	1ST WEEK	2ND WEEK	3RD WEEK	4TH WEEK	AVERAGES
Injected group					
47	1.2	1.2	1.4	1.3	1.275
51	1.3	1.4	1.4	1.4	1.375
52	1.3	1.3		1.3	1.3
54	1.3	1.2	1.3	1.3	1.275
61	1.4	1.4	1.4	1.4	1.4
63	1.3	1.3	1.4	1.3	1.375
92	1.3	1.2	1.3	1.2	1.25
93	1.4	1.3	1.4	1.4	1.375
				General average,	1.328
Control group					
101	1.1	1.1	1.0	1.1	1.075
103	1.0	1.0	1.0	0.9	0.975
107	1.2	1.1	1.1	1.1	1.125
116	1.1	1.0	0.9	1.0	1.0
122	1.0	1.0	1.0	1.0	1.0
123	0.9	0.9	0.9	1.0	0.975
133	0.9	1.0	0.8	0.9	0.9
134	1.0	0.9	1.0	0.9	0.95
				General average,	1.000

* Figures in the first column represent the identification numbers of the animals.

growth of the incisors was about 1.0 mm. per week in normal untreated animals. Of thirty-eight injected animals, each showed a greater rate, the average being 1.3 mm. per week. *Table 1* gives the actual measurements of one group of injected animals and one group of controls studied in this way for a period of four weeks, the data being typical of the growth rate throughout.

Microscopic Studies

The most marked cell difference in the two types of animals was noted in the livers and internal female genitalia. Somewhat less marked, but quite evident, were changes in the lymphogenic tissues.

FIG. 5. WHOLE ORGANS FROM TREATED AND CONTROL LITTER-MATE MICE, TEN WEEKS OF AGE

Vertical rows, left to right. *First row:* downward—skull, internal female genitalia, liver, kidney, of injected female. *Second row:* same organs of untreated control litter-mate female. *Third row:* skull, liver, kidney, of injected male. *Fourth row:* same organs of untreated control litter-mate male. (Male genitalia show no distinctive difference.)

Less striking, but evident, were changes in the kidneys. Other variations were too slight to require attention. A very marked splanchnomegaly, in all of the injected animals, was most noticeable in the liver and internal female genitalia; less so in the kidney. In the liver, there was a very great increase in the size of the cell nuclei in the injected animals; a slight increase in the total size of the cells; marked destruction of the cells around the central vein, which extended half-

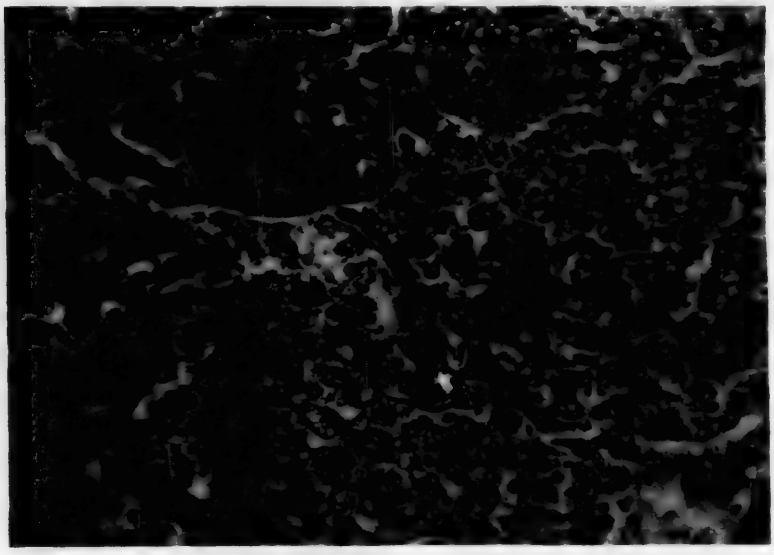

FIG. 6. PHOTOMICROGRAPH OF LIVER OF UNTREATED CONTROL FEMALE, SHOWING COMPACT NUCLEI AND GENERAL COMPACT ARRANGEMENT OF HEPATIC CELLS (× 160)

way or more through the lobules, in many cases amounting to complete destruction and necrosis of the cells; some increase in the lymphocytes in these regions; and possibly a slight tendency to increase in interstitial connective tissue; the blood vessels, in particular the central veins, were considerably enlarged and thin-walled (*figs. 6* and *7*).

Findings. In the uterus, tubes, and ovaries, besides increase in gross size (*fig. 5*), there was no apparent difference in the stage of development of the ovarian follicles; a possible slight advancement in the stage of the endometrium and endometrial glands; a thickening and

increase in quantity of the myometrium and walls of the tubes (the most marked change); and a possible increase in the epithelial lining of the uterus, and particularly of the vagina. In the kidneys most of the changes were in the region of the convoluted tubules, where there was much cloudy swelling in the tubular epithelium and some increase in the connective tissue elements between the tubules; also a notable congestion of the capillaries.

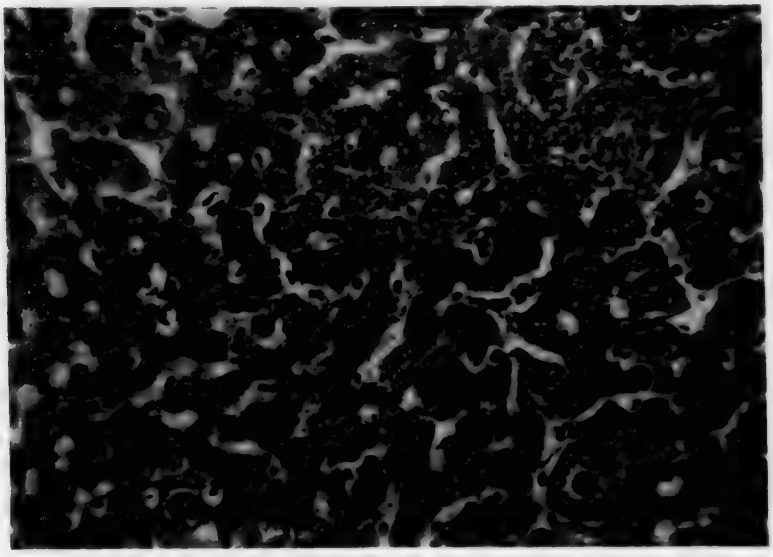

FIG. 7. PHOTOMICROGRAPH OF LIVER OF INJECTED FEMALE

Litter-mate of one in *Fig. 6*. Shows larger, less dense nuclei, larger hepatic cells, and distension of blood sinuses in general (× 160)

The mandibulae of many of the animals, injected and control, were fixed in formalin, formol-Zenker's, or Bouin and Susa fixatives; decalcified in 5 per cent nitric acid or 5 per cent trichloracetic acid; neutralized with lithium carbonate in 1 per cent solution; embedded in paraffin, or celloidon, or double-embedded; sectioned; and stained variously with methylene blue, iron hematoxylin, Delafield's hematoxylin and eosin, haemalum and Congo red, or Masson's trichromic stain. Of each series a few were tried with the mitochondrial stains of

Cowdry and Benda. The most careful examination showed no regular variation in the histology of the continuously growing incisors, molars, or surrounding bone. There was no evidence of osteodentin formation in the pulps, and no change in the odontoblasts or ameloblasts. The mitochondrial stains showed no regular variations in the cytoplasmic inclusions. Microscopic examination revealed no notable difference in density of bone, dentin, or enamel. In short the microscopic pic-

FIG. 8. ENLARGED PRINT OF X-RAYS OF MANDIBULAE OF EXPERIMENTAL AND CONTROL MICE

Top, left: mandible of injected female. Bottom, left: mandible of litter-mate control female. Top, right: mandible of injected male. Bottom, right: mandible of litter-mate control male, showing difference in both size and density between injected and control animals.

ture was entirely negative, so far as mandible and teeth were concerned (*figs. 25–31, 35–37*).

X-ray studies of the maxillae and bones of the two types of animals were made. Owing to the very small size of the long bones, the findings relating to them were not significant. The maxillae and the incisors, however, were much larger and denser in the injected animals than in the controls (*fig. 8*). Whether this is disproportionate to the total rate of growth of the animals is a matter for conjecture. Although

difficult to demonstrate, it is felt that the increase in rate of growth as well as the increase in size, of the continuously growing teeth of the injected animals, is only about proportional to the rate of increase of their general somatic growth, and represents no specific action.

III. STUDIES ON DOGS

Owing to the well known variations of individuals, even within fairly regular types of animals, it seemed essential in these studies to use litter-mates of a closely inbred type. To facilitate handling it was necessary that the animals should be small. Fox terriers in fairly large litters, and of a closely inbred strain running from eight to ten weeks of age, were selected. When the first litter was obtained, attempts were begun to hypophysectomize several of each sex. The method outlined by McLean (110) was in general utilized; but, owing to the fact that his animals were obviously larger, some changes were necessary. A modification of the operating table and appurtenances described by McLean was worked out in the animal operating room of the Department of Surgery of Yale University, which made it possible to hold the dogs immovable, and have access to the soft palate and pharynx with relative ease.

In the first few operations chloralose, paraldehyde, and amytal were tried variously to determine which would give the best results. These were obtained consistently with amytal when dogs, which had fasted for twenty-four hours, were given intraperitoneally 50 mg. per k. about three quarters of an hour before the operation, and their stomachs washed before receiving a small amount of atropin by stomach tube to lessen secretion from the mucous membranes on which the operation was to be done. The initial stages of the operation were done as outlined by McLean until the point of incising the mucoperiosteum was reached. Here, with animals so small as those in use, it was not practicable to use guy sutures on the delicate tissues involved and in the small working space allowed. Instead, a V-shaped flap was cut and turned back posteriorly out of the field of operation. The bony fault was then made with a large round dental bur, and cautiously followed down to the cranial layer of periosteum, which was carefully denuded of all bony fragments, incised with a small lance-shaped instrument, and access made to the underlying dura. With practice

it was possible to locate the dura overlying the hypophysis and to incise that. When this was cautiously done and a small fault made, the hypophysis gradually worked through the incision as the pulsations in the intra-cranial pressure changed its position. After it had completely pushed through, it was carefully excised with a small round rongeur. In many instances, in completing these stages, openings were made into the circular sinus, which lies very close in the dog, whereupon the animals bled to death or died shortly after the opera-

FIG. 9. ENLARGED (4 ×) GROUND SECTION THROUGH LOWER RIGHT CANINE OF INJECTED MALE DOG AT AUTOPSY

No lines of deposition of dye can be seen. All elements are approximately same size.

tion from subdural hemorrhage. This seemed to be the cause of the greatest loss. Following hypophysectomy, a few animals were lost from convulsions, which at autopsy seemed in no way connected with hemorrhage or local trauma. These losses were classed as being due to "acute pituitary insufficiency," although the term is considered quite unsatisfactory. Following removal of the entire gland in the earlier cases, an attempt was made to close the bony fault with bone wax or with a plug of bone, but the results were so unsatisfactory that

in the later operations the effort was discontinued. Instead, the area was carefully cleansed with 1 per cent mercurochrome and the flap in the muco-periosteum brought down over the flaw, where it stayed in place fairly well. The soft palate was sutured, and the area again scrubbed with mercurochrome; and the dog kept warm until well out of the anesthesia.

Four dogs in all, two of each sex, were finally available. Each was grouped with one of the same sex and litter that received the alkaline

FIG. 10. ENLARGED (4 ×) GROUND SECTION THROUGH LOWER RIGHT CANINE OF CONTROL MALE DOG, LITTER-MATE OF THAT REPRESENTED IN FIG. 9

No lines of deposition of dye can be seen. All elements are approximately same size.

extract (described by Evans and somewhat modified as indicated earlier); another of the same sex and litter was kept untreated, but handled and fed in an identical manner as a control.[6] As soon as it became evident that a given hypophysectomy had been done with reasonable

[6] Owing to the quantities of extract necessary for these studies, it became necessary to call for further help. Arrangements were made with the department of experimental medicine of Parke, Davis & Company to supply, in large quantities, the alkaline extract made in accord with Evans, Cornish, and Simpson's last modification (55).

hope of success, these groupings were made, and the animals weighed, and examined for variations in hairy coat, build, and dentition. They were re-examined and weighed at intervals of two weeks throughout the progress of the experiment. The animals that received the injections of alkaline extract of the anterior lobe, at the beginning were given intra-peritoneally 3 cc. daily. The injections were made with reasonably aseptic precautions, and the extracts warmed to approximately body temperature before injection. The dosage was gradually

FIG. 11. ENLARGED (4 ×) GROUND SECTION THROUGH LOWER RIGHT CANINE OF HYPOPHYSECTOMIZED MALE DOG, LITTER-MATE OF ANIMALS REPRESENTED IN FIGS. 9 AND 10
No lines of deposition of dye can be seen. All elements are approximately same size

increased as the animals became older and larger. By varying the dosage and observing the response, the optimum results were obtained from a dosage of slightly more than 1 cc. per pound of body weight.

As has been said, the experiment was begun with four groups of animals: two, male; two, female. In about six weeks, one of the male groups was killed and autopsied. Thus early in the course of the study, there were noted some slight changes that accorded with results in the later autopsies. Fourteen weeks after the beginning of the experiment, a group of females was killed and carefully examined. Two days

FIG. 12. LITTER-MATE MALES AFTER SIX WEEKS OF TREATMENT

Left: hypophysectomized. *Center:* untreated control. *Right:* injected. At outset, the hypophysectomized animal was slightly larger than the control; the injected animal was much the smallest.

FIG. 13. THE SAME GROUP OF LITTER-MATE MALES, IN FIG. 12, AFTER FIVE MONTHS OF TREATMENT

Note the loose, baggy skin and general "cretinoid" appearance of the operated animal; also the foot, ankle, and postural changes in both animals; and the marked size-increase in the injected animal.

later, owing to a pulmonary infection, it was necessary to sacrifice the other group of females, which were thoroughly studied. Of the remaining group of males, after twenty-one weeks the injected animal died from an apparent toxicosis, which made it necessary then to autopsy this group.

General findings. The permanent dentition erupted at a much earlier age in the animals that received the alkaline extract of the anterior

TABLE 2

Summary of effects noted at autopsies (one group of dogs)

	HYPOPHYSECTOMIZED	CONTROL	INJECTED
Gross weight at start	5 lb., 14 oz.	5 lb., 2 oz.	4 lb., 2 oz.
Gross weight at end	8 lb., 2 oz.	8 lb., 10 oz.	10 lb., 2 oz.
Amount of fat present	Large amount	Little	None
Liver	Wt. 118.4 gm.; normal	Wt. 188.5 gm.; normal	Wt. 268.9 gm.; focal necrosis
Genitalia	Small, delicate	Moderate	Large, heavy
Tongue	Small, rough	Moderate	Large, heavy
Skull	Small; under-developed in frontal and pre-maxillary regions	Moderate; normal	Large; frontal region bulging; maxillae large and heavy
Mandible	7.5 cm. x 2 cm.; light in texture	8.0 cm. x 2.3 cm.; normal	8.5 cm. x 2.8 cm.; heavy, dense
Teeth	Delayed eruption; "tumbled" in arch	Normal	Advanced eruption; "spaced" in arch
Cuspids	Greatest diameter, 6.1 mm. Tip to apex, 22 mm. Thickness of wall, 2 mm.	Greatest diameter, 6.0 mm. Tip to apex, 22 mm. Thickness of wall, 2 mm.	Greatest diameter, 6.1 mm. Tip to apex, 21 mm. Thickness of wall, 2 mm.

lobe than in the controls or the hypophysectomized animals. The latter were much slower in this respect than the controls or the injected ones. There was no observable variation in the size or form of the teeth, but some increase in the size of the maxilla in the injected animals, and a decrease in these bones in the hypophysectomized ones, causing a definite spacing of the teeth of the injected dogs, and crowding

and "flaring" of the teeth in the hypophysectomized ones, neither condition occurring in the controls (*figs. 23* and *24*). The injected dogs had a somewhat denser growth of hair, and were sleeker in appearance and much larger for a considerable period of their growth, while the hypophysectomized animals showed the opposite tendency (*figs. 12* and *13*). Strangely, although the difference in bony development between the two groups was very noticeable, both of the treated types

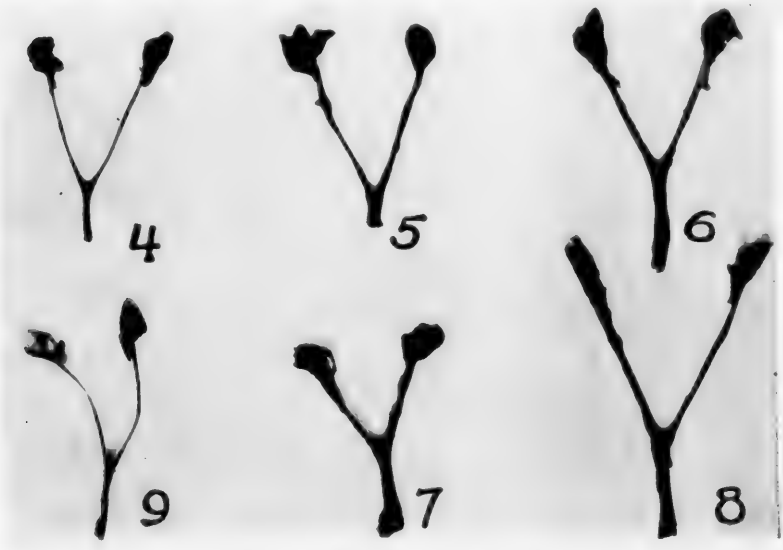

FIG. 14. PHOTOGRAPHS, HALF-SIZE, OF OVARIES, TUBES AND UTERI OF TWO GROUPS OF FEMALE DOGS

4 and *9*, organs of hypophysectomized animals; *5* and *7*, organs of control animals; *6* and *8*, organs of injected animals.

had a weakness of the ankles that was not observed in the controls. The injected dogs showed an extreme lethargy, and dullness of a sort, while the hypophysectomized ones were very nervous and excitable. At autopsy, the injected animals in addition to marked general gain in weight, exhibited an even disproportionate increase in the size of the viscera, most marked in the liver—in the females, in the uterus and tubes; no similar changes were noticed in the internal male genitalia, but in both sexes, the kidney was somewhat larger. The hypophy-

sectomized animals showed the greatest amounts of subcutaneous, mediastinal, and mesenteric fat; the injected animals, the least. In the injected females, there was a marked tendency to enlargement of the external genitalia and vulvae, which were pendulous and hypertrophic; the hypophysectomized animals were definitely infantile in this direction, and showed an almost complete lack of development in the internal genitalia (*fig. 14*). In the injected animals the tongue was considerably increased in size, and there was general unwieldiness in its use; no change in this respect was noticed in the hypophysecto-

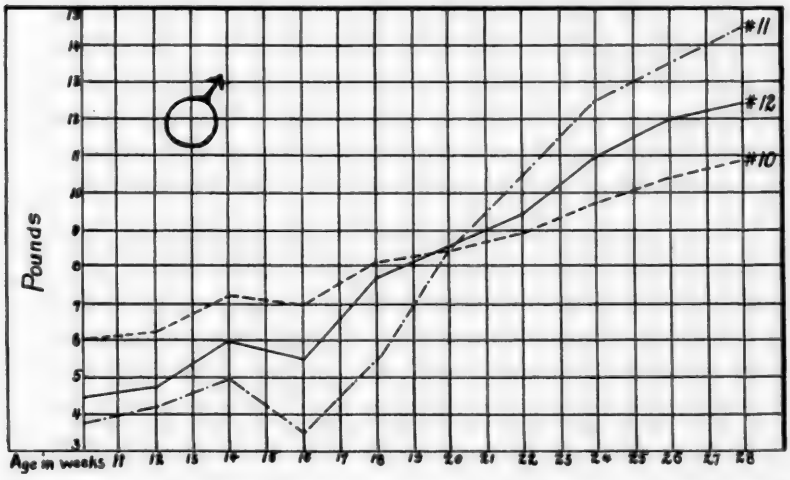

FIG. 15. GRAPH OF GROWTH CURVES FOR LITTER-MATE MALES SHOWN IN FIGS. 12 AND 13
11, alkaline-injected; *12*, untreated control; *10*, hypophysectomized.

mized dogs. The changes in a group of females are summarized in *Table 2*, and the autopsy protocols appended at the end of the paper. The protocols for the other group of females, while differing in details, reveal essentially the same relative findings as those in *Table 2*. The same conditions governed in a somewhat more advanced degree in the group of males that was continued six weeks longer.

In each group, the heaviest animal had been selected for hypophysectomy, the lightest for injections, as there was excellent reason to believe that the operation would retard the rate of growth, and the injections accelerate it. At the end of each experiment, the hypophy-

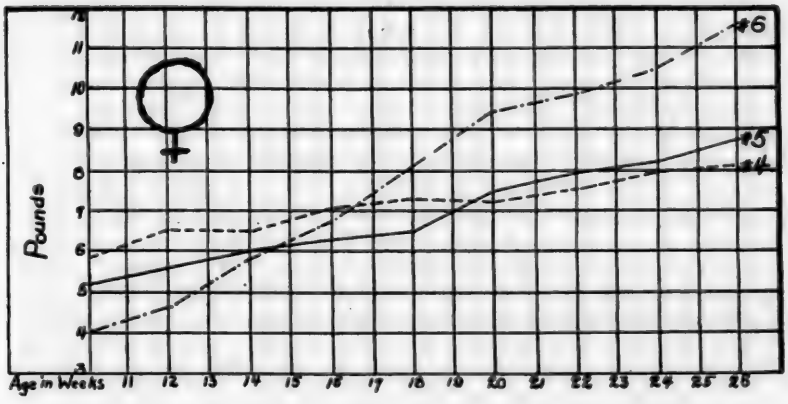

FIG. 16. GRAPH OF GROWTH CURVES FOR LITTER-MATE FEMALES AUTOPSIED AFTER SIXTEEN WEEKS OF TREATMENT

4, hypophysectomized; *5*, untreated control; *6*, alkaline-injected.

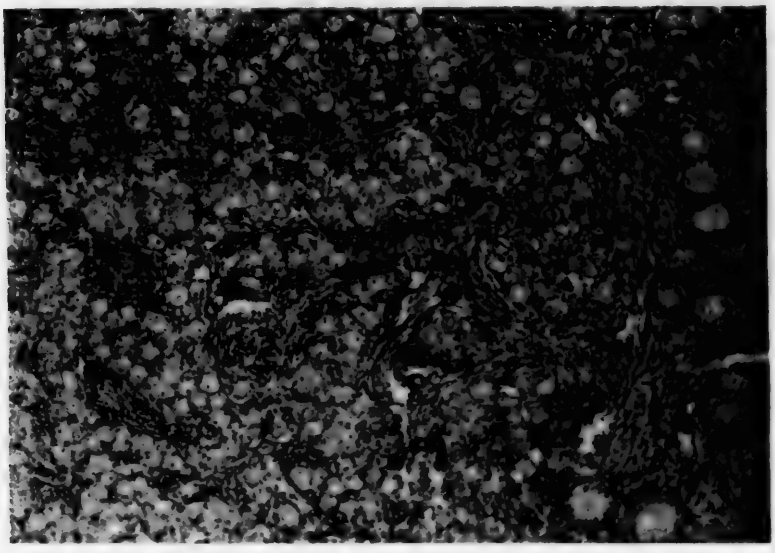

FIG. 17. PHOTOMICROGRAPH OF OVARY OF HYPOPHYSECTOMIZED DOG (LITTER-MATES FIGS. 18 AND 19). SHOWING INFANTILE TYPE OF OVA, WITH NO TENDENCY TO FOLLICLE FORMATION (× 140)

sectomized animals were the lightest; the injected, by far the heaviest (*figs. 15* and *16*). The differences noted in the viscera were constant for the animals on a similar type of handling.

Microscopic findings. Liver. In the liver there was a slight increase in the size of the cell nuclei in the injected animals; atrophy and necrosis of the cells at the center of the lobules; and some infiltration of plasma and polymorphonuclear cells as well as lymphocytes, and a slight increase in the interstitial connective tissue, in these re-

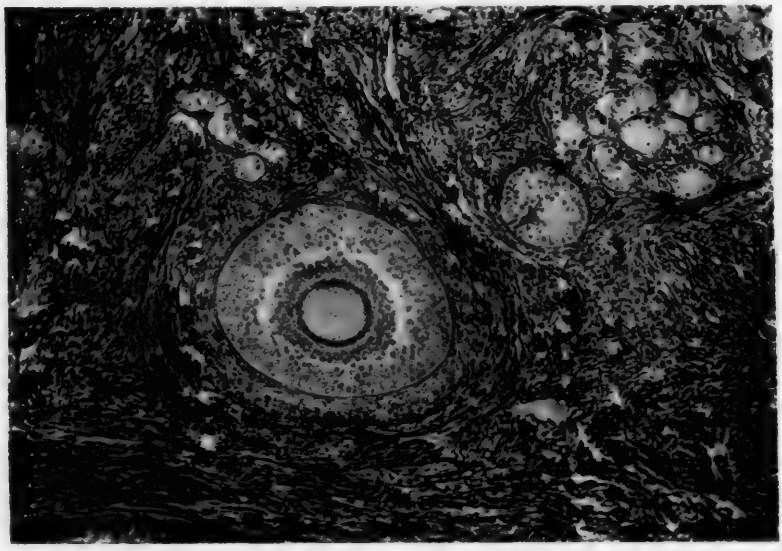

FIG. 18. PHOTOMICROGRAPH OF OVARY OF UNTREATED LITTER-MATE CONTROL (FIGS. 17 AND 19), SHOWING ADVANCED FOLLICLE FORMATION (× 140)

gions. There was also some congestion of the blood sinuses. The nuclei of the cells of the injected dogs take the nuclear stains less intensely than those from the control or hypophysectomized animals, the latter showing a very deep nuclear stain.

Kidney. The kidneys of the control and hypophysectomized animals showed no advanced microscopic differences. However, in the injected animals, there was a moderate degree of cloudy swelling in the tubular epithelium, most apparent in the convoluted portions. In

these loci also, there was infiltration of lymphocytes and increase in interstitial connective tissue, and a slight amount of congestion of the capillaries.

Ovaries. The ovaries of the hypophysectomized animals were very small and infantile, containing no advanced follicles and a very dense ovarian stroma (*figs. 17, 18,* and *19*). The tubes and uteri, grossly much smaller, exhibited no advanced stages of endometrial changes, and only a very thin wall and myometrium. In the controls the

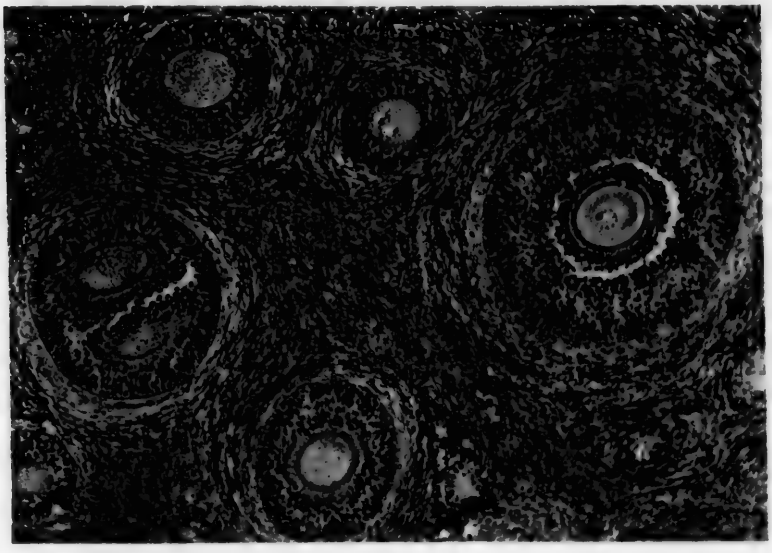

FIG. 19. PHOTOMICROGRAPH OF OVARY OF INJECTED LITTER-MATE (FIGS. 17 AND 18), SHOWING FOLLICLES AT A STATE OF ADVANCEMENT THAT DIFFERS PROBABLY ONLY A FEW HOURS FROM THE CONTROL, BUT HAVING A LARGER AMOUNT OF STROMA (× 140)

ovaries, tubes, and uteri were larger. The ovaries showed a number of advanced but not ripe follicles; the tubes and uteri, some changes in the lining glands of a proliferative character, and a very great thickening of the walls and myometrium. In the injected animals, compared with the controls, there was no change in the condition of the follicles or endometrial glands or epithelium, but a very marked increase in the stroma in the ovary, and in the myometrium and connective tissue in the tubes and uteri.

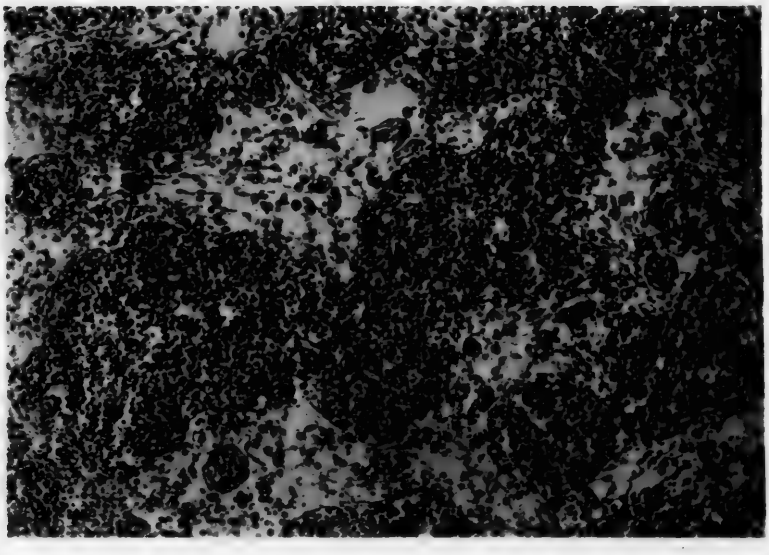

FIG. 20. PHOTOMICROGRAPH OF CERVICAL LYMPH-NODE FROM CAROTID GROUP IN HYPOPHYSECTOMIZED FEMALE (LITTER-MATES, FIGS. 21 AND 22), SHOWING RELATIVELY GREAT DENSITY OF LYMPHOCYTES (× 80)

FIG. 21. PHOTOMICROGRAPH OF CERVICAL LYMPH-NODE FROM SAME REGION OF LITTER-MATE CONTROL FEMALE DOG (FIGS. 20 AND 22), SHOWING SLIGHTLY LESS DENSITY OF LYMPHOCYTES AND RELATIVE INCREASE OF RETICULAR ELEMENTS—AN APPROXIMATELY NORMAL PICTURE (× 80)

Lymphogenic organs. In the injected animals, the thymus and cervical lymph glands in particular, and lymph glands in other regions of the body (but not in the spleen), were enlarged. Microscopically there was a thinning out of lymphocytes in the organs, with an apparent relative increase in the amount of reticular tissue, which also had a loose edematous appearance. In the hypophysectomized animals, in which the organs are relatively smaller (this includes also the thymus), these gross conditions were more marked. Microscopically there was

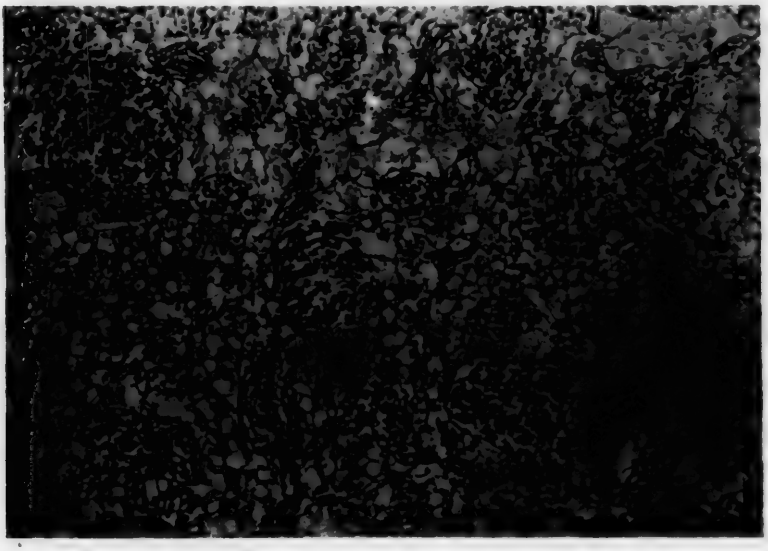

FIG. 22. PHOTOMICROGRAPH OF CERVICAL LYMPH-NODE FROM SAME REGION IN INJECTED LITTER-MATE FEMALE (FIGS. 20 AND 21), SHOWING RELATIVE THINNING OUT OF LYMPHOCYTES AND DISTINCT EDEMATOUS APPEARANCE OF RETICULAR TISSUE (× 80)

a relatively greater amount of lymphocytes, with a smaller amount of reticular tissue and none of the edematous appearance (*figs. 20, 21,* and *22*). In the controls, conditions were between the two types of treated animals in relative proportions of lymphocytes and reticular tissue, but there was no edematous state of the latter.

In the other visceral organs—*lungs, heart, intestinal tract,* etc.—there were no significant changes. The *male genitalia,* in both the first and last groups, revealed no marked microscopic differences.

Teeth. Microscopic study of the teeth was very disappointing. All of the animals received injections of trypan blue intra-peritoneally at intervals of a month. It was hoped that this would reveal lines of deposition in the dentin. The upper right cuspid tooth of each autopsied animal was fixed for ten days in neutral formalin, dehydrated, embedded in block in benzol damar, and ground in mid-sagittal section to 50 micra in thickness. This was mounted in balsam and carefully examined under the dissecting microscope. No evidence of deposition of trypan blue could be seen in any case (*figs. 9*, *10*, and *11*).

FIG. 23. FRONT VIEW OF ANTERIOR TEETH OF (LEFT) HYPOPHYSECTOMIZED MALE, *10*, SHOWING TUMBLING AND "FLARING" OF INCISORS AND CUSPIDS, AND OF (RIGHT) INJECTED LITTER-MATE MALE, *11*, SHOWING LARGER MAXILLAE, SPACING AND VERTICAL POSITION OF INCISORS AND CUSPIDS. SEE FIG. 24

Some of the remaining cuspids and other teeth were decalcified, sectioned, and stained; others ground to microscopic thinness, stained, and mounted for histological study. Sections stained with iron hematoxylin, hematoxylin and eosin, haemalum and congo red, and the trichromic stain of Masson, revealed no changes in the arrangement of enamel rods, apparent density of dentin, or variation in dentinal tubules. There was no variation in the calcified trabeculae of the surrounding bone. In no instance did the ameloblasts and odontoblasts show deviation in regularity of arrangement, or in relationship in size

or outline between cells and nuclei. Staining qualities of the hard structures, pulpal cells, and cells of the surrounding tissues, were not

FIG. 24. LATERAL VIEW OF HEADS OF SAME ANIMALS (FIG. 23)

Top: injected; showing frontal bulging, larger head and jaws, and vertical position of anterior teeth. *Bottom:* hypophysectomized; showing frontal flattening, smaller head and jaws, and "flaring" of anterior teeth due to diminished arch.

changed in either type of treated animal. Neither was their arrangement altered (*figs. 32–34, 38–40*). Many sections were stained with

Cowdry's mitochondrial stains, which, despite the ill effects of decalcification, revealed numerous cell inclusions, especially in the amelo-

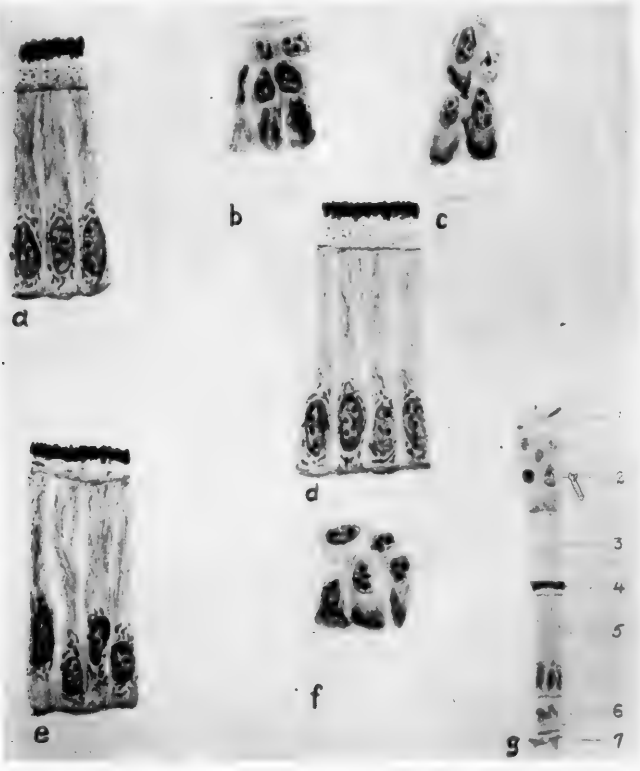

FIG. 25. DRAWINGS OF CELLS FROM GROWING TEETH OF DOGS

a, ameloblasts from injected animal. *b*, odontoblasts from same animal. *c*, odontoblasts from control. *d*, ameloblasts from same animal. *e*, ameloblasts from hypophysectomized animal. *f*, odontoblasts from same animal. *g*, orientation sketch through developing root, showing (1) pulpal cells, (2) odontoblasts, (3) forming dentin, (4) forming enamel, (5) ameloblasts, (6 and 7) surrounding connective tissue cells. All stained for mitochondria after Cowdry. Inclusions may be seen clustering about the nuclei of the ameloblasts, but there were no differences for types of treatment.

blasts. For each type of animal these tended to clump around the nucleus, and showed no variation in accord with the types of handling (*fig. 25*).

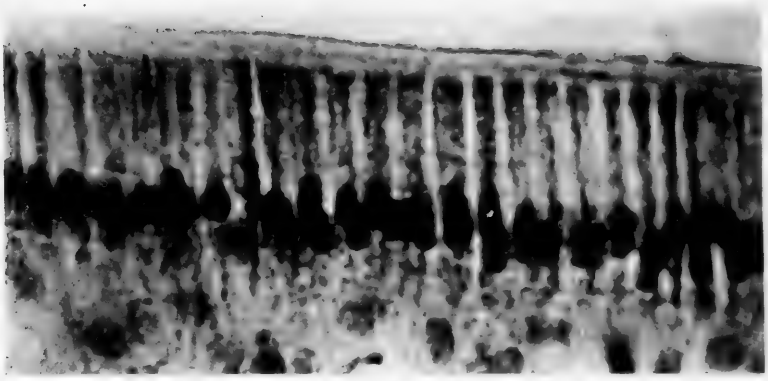

FIG. 26. PHOTOMICROGRAPH OF AMELOBLASTS FROM CONSTANTLY GROWING INCISOR OF CONTROL MOUSE DECALCIFIED H. AND E. SECTION. SEE FIGS. 27 AND 28 (× 1200)

FIG. 27. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM INJECTED MOUSE. LITTER-MATES: FIGS. 26 AND 28

FIG. 28. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM ANOTHER CONTROL MOUSE. NO DIFFERENCES IN ARRANGEMENT OR STAINING QUALITIES OF CELLS. LITTER-MATES: FIGS 26 AND 27

IV. CONCLUSIONS AND COMPARISONS OF RESULTS

Were it not possible to draw upon the work of earlier investigators, it still would be quite clear that the present work demonstrates the presence of a definite growth-promoting principle in the anterior lobe of the pituitary gland. In each instance, with each type of animal, a general increase in size and weight has been obtained by increasing the

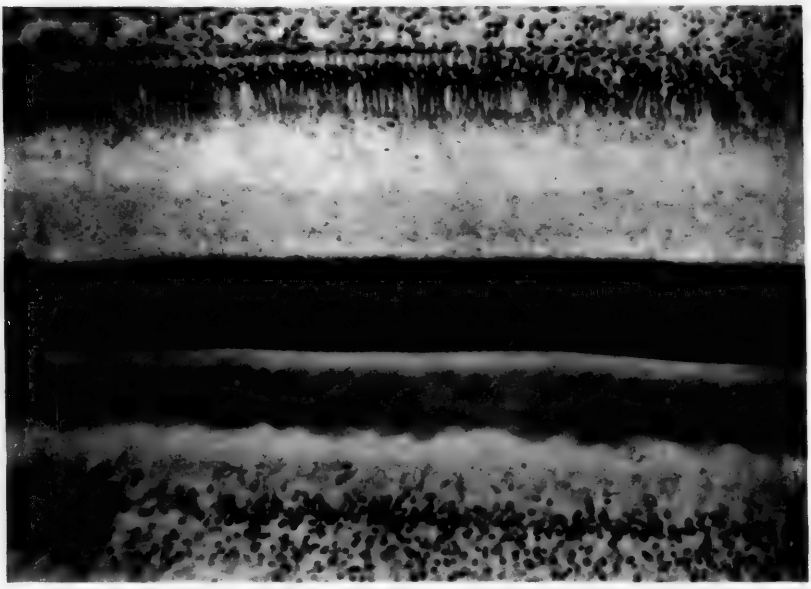

FIG. 29. PHOTOMICROGRAPH OF SECTION THROUGH WALL OF CONSTANTLY GROWING INCISOR OF INJECTED MOUSE, SHOWING ODONTOBLASTS ABOVE; FORMING DENTIN, FORMING ENAMEL (ON LABIAL ONLY), AMELOBLASTS BELOW. DECALCIFIED H. AND E. SECTION (× 600). SEE FIGS. 30 AND 31.

available quantity of the growth-promoting principle. In dogs, loss or ablation of the gland definitely inhibited growth in each case. It is true that these changes have not been parallel or identical in degree in all tissues or organs of a given animal. This does not, however, mitigate the fact that the difference was general, and exercised in the same direction for all of the animals on a given type of treatment. Stockard (73, 76), Donaldson (32), Jackson (88, 89), Scammon (150), and others,

have shown that growth is not a constantly increasing process in each of the tissues and organs, in the same degree. General growth goes on at a variable rate, in the same animal. Growth of the organs and tissues proceeds at different rates in the same individual over the same period. Such would seem to be the case with the growth stimulation caused by this principle from the anterior lobe. There was a general increase in size and growth of the animals injected, but this increase

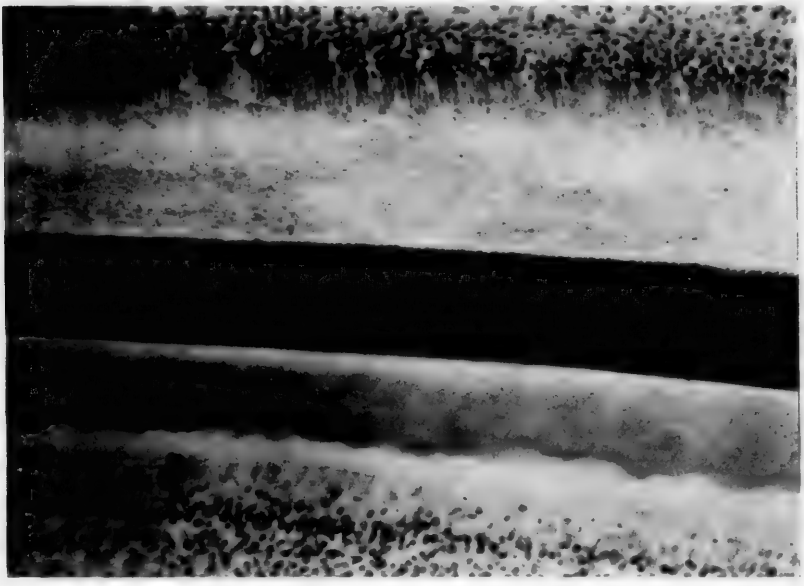

FIG. 30. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF LITTERMATE CONTROL. SEE FIGS. 29 AND 31

was more marked in certain organs than in others. The livers and internal female genitalia showed the greatest changes. The kidneys and lymphogenic organs were next in degree. The remaining organs, including the teeth and jaws, apparently shared only in the general increase—evidenced in the teeth by accelerated rate of eruption, but not by increase in size or by change in form; in the jaws, by increase in size as well.

Owing to microscopic conditions in the liver, kidneys, and lympho-

genic organs, possibly a part of their increase in size was due to a toxic effect of the experimental procedure. The nature of this toxic influence is difficult to determine. Possibly a toxic product arose during the preparation of the extract. But the fact that the effects seem to be very similar, almost regardless of the method used, does not point in this direction. Perhaps if cell metabolism is stimulated to a very

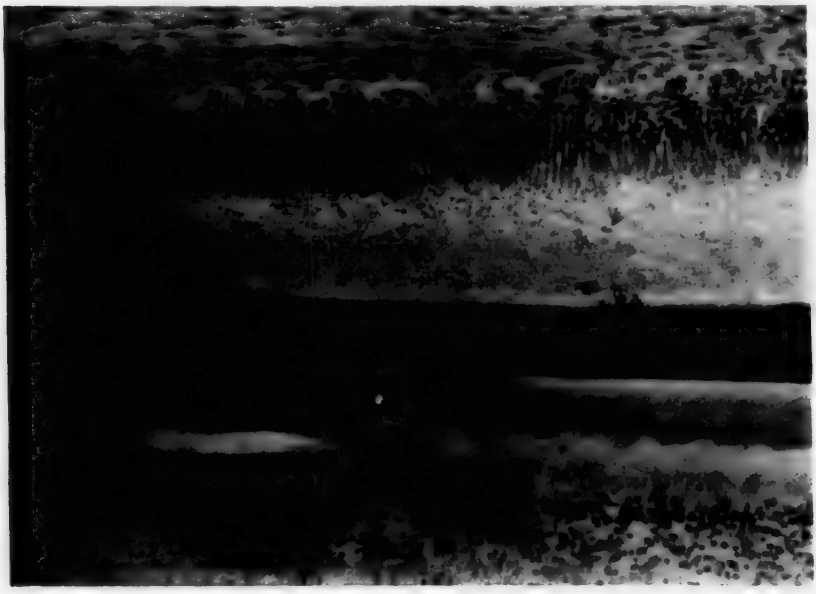

FIG. 31. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF INJECTED LITTER-MATE. THERE ARE NO DIFFERENCES IN SIZE, ARRANGEMENT, OR STAINING QUALITIES OF CELLS, OR HARD SUBSTANCES. SEE FIGS. 29 and 30

advanced degree, the by-products of this rapid change may be so abundant that they cannot be properly taken care of by the eliminative processes of the animal, with resultant toxic effect. In any event, it is obvious that, in dogs and mice, injection of the available extracts, with perhaps the exception of the "globulin" fraction (183)—which was not carefully studied in this instance—induces not only a marked general growth-effect, but also a definite toxic action that is most noticeable

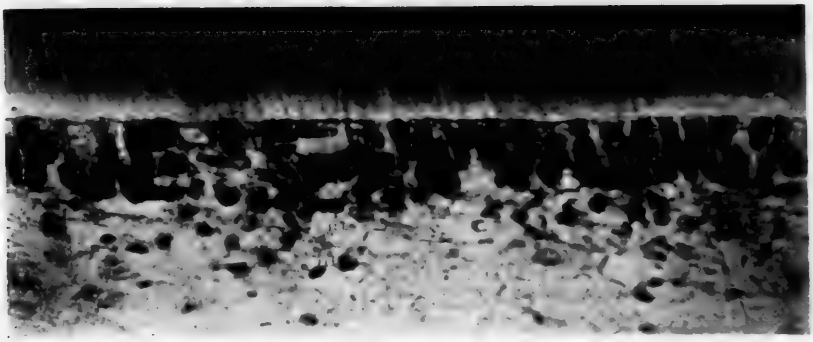

FIG. 32. PHOTOMICROGRAPH OF ODONTOBLASTS AND DENTIN FROM TOOTH OF HYPOPHYSECTOMIZED DOG. DECALCIFIED, MASSON-STAINED SECTION (× 800). SEE FIGS. 33 AND 34

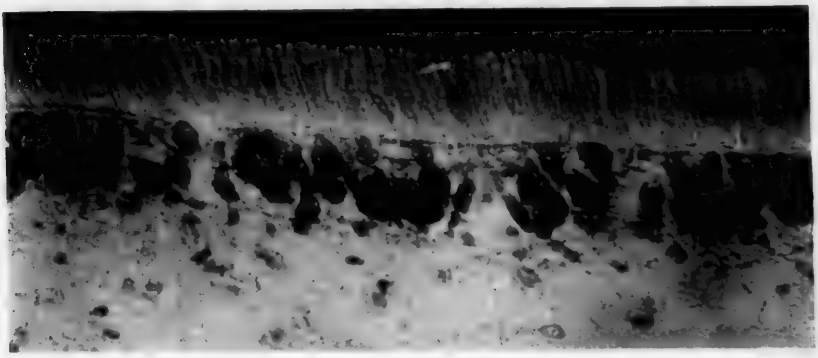

FIG. 33. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF LITTER-MATE CONTROL. SEE FIGS. 32 AND 34

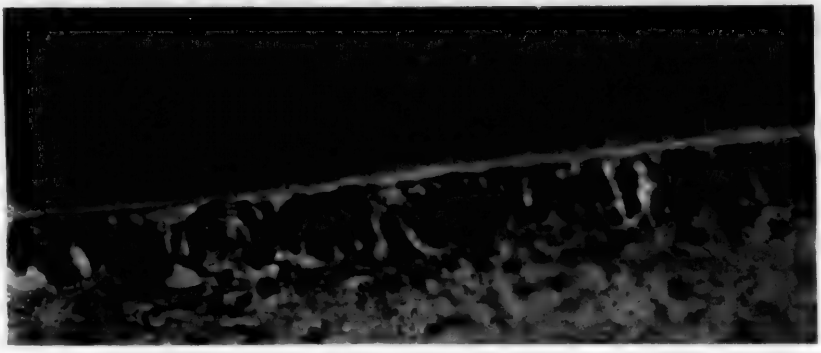

FIG. 34. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF INJECTED LITTER-MATE. THERE ARE NO DIFFERENCES COMPARED WITH FIGS. 32 AND 33

in the cells at the center of the lobules in the liver; slightly less so in the kidneys and lymphogenic organs.

The chemical changes noted in the mouse-injection experiments are particularly significant. The injections caused a continued high water content, with a somewhat complementary slower increase of fat content than in the controls. An analogous general effect was observed in the similarly treated dogs. Injections into mice caused a

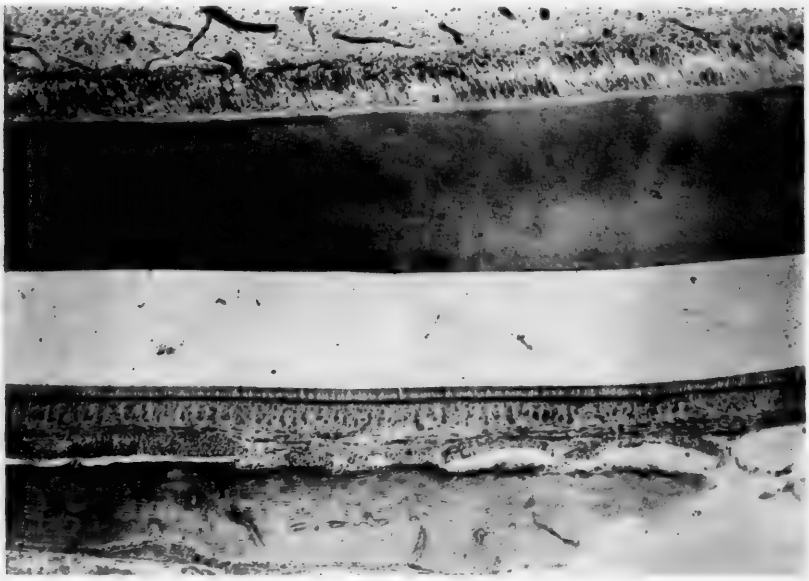

FIG. 35. PHOTOMICROGRAPH OF SECTION THROUGH WALL OF CONSTANTLY GROWING INCISOR OF INJECTED MOUSE. H. AND E. DECALCIFIED SECTION. (× 100). SEE FIGS. 36 AND 37

definite rise in the total ash content. Referring to Moulton's excellent study on tissue content, and paralleling it with Donaldson's on growth-rate at different periods, it appears likely that the chemical phenomena in the present studies, and usually found in somewhat younger animals, are parts of the picture of markedly stimulated growth, and were observed at the different ages because the repeated injections carried a normally early growth rate into a later period chronologically.

Apparently the rate of growth noted by Donaldson, in the "third phase," has been extended into a later time period. This should likewise account for the great increase in rate of eruption of the permanent dentition.

It is not impossible, but seems quite unlikely, that the recorded changes in water, fat, total ash, and nitrogen contents, are a part of the picture of toxicosis as revealed by the microscope. These changes, as

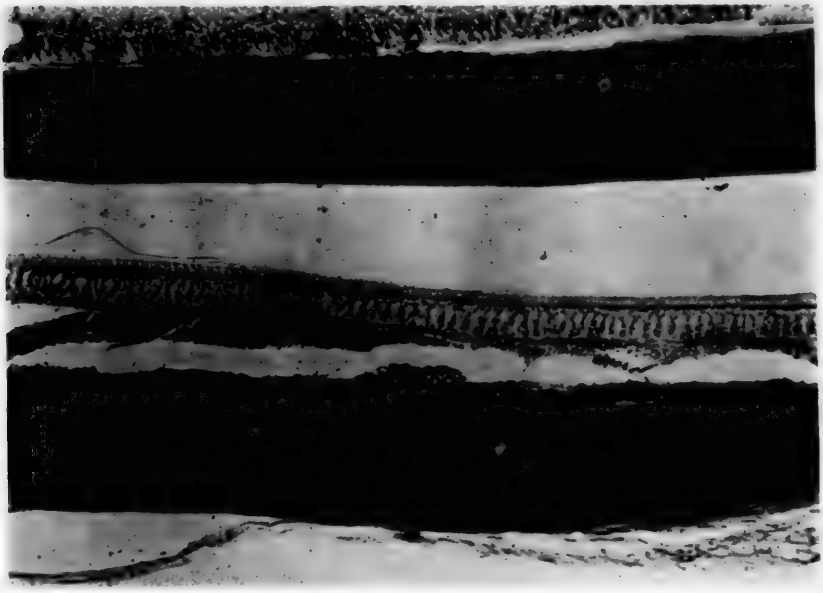

FIG. 36. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION, FROM CONTROL LITTERMATE. SEE FIGS. 35 AND 37

indicated by the curves plotted in each case (*figs. 3* and *4*), are nearly identical with those at different growth stages in Moulton's studies. It is more likely that the chemical differences represent simply differences in growth acceleration.

The changes in the internal female genitalia are very marked and the interpretation seems obvious. Ablation or excision of the hypophysis caused a retardation of the sex apparatus in all directions. This is logical in view of the fact that excision of the entire gland removes from

the animal the sex-stimulating principle necessary to normal sexual development. In the case of untreated controls, growth, both general and sexual, proceeded at a normal rate. The genitalia of these animals were much further advanced in each direction than those in the operated animals. In the genital organs of injected animals there was an increase in size and stroma compared with the control animals, but no notable difference in the sex-elements proper. Apparently the in-

FIG. 37. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION, FROM CONTROL LITTERMATE. NO DIFFERENCES ARE NOTED. SEE FIGS. 35 AND 36

crease in size and stroma in this case was a phenomenon of general body growth, stimulated by the injection of the growth principle. But inasmuch as the sex-stimulating effect was only that of a normal animal, the picture of the sex-elements is not changed from that seen in the controls. The sex-elements in the males were not similarly affected, presumably because the male sex-mechanism is much less labile than that of the female.

The studies of Dott (33), Dott and Fraser (34), and others, have re-

vealed that there are fairly regular changes in the long bones in the various types of pituitary experimentation. They obtained definite changes in both hypo- and hyperpituitarism experimentally produced. X-ray studies on my animals were negative in this respect, except as to density and size of mandibulae and teeth in mice, and density of mandibulae in dogs. This observation does not necessarily contradict the finding of Dott and Fraser, but may indicate merely that many

FIG. 38. PHOTOMICROGRAPH OF SECTION THROUGH WALL OF GROWING TOOTH OF INJECTED DOG. DECALCIFIED H. AND E. SECTION. (× 80)
SEE FIGS. 39 AND 40

factors in addition to the purely personal one of interpretation, affect x-ray findings. The youth of my animals, even at the termination of the experiments, might have been a factor; faulty x-ray technic another. However, the lack of x-ray evidence is quite definite, except, as mentioned, in the mandibulae. These were denser in the injected animals of both types, but showed no difference as between hypophysectomized and control dogs. X-rays of the mandibulae of mice showed also increase in size of both teeth and bone. In the injected

dogs, increase in size and density of the bone was evident. Owing to the difference in maxillary size, the arrangement and spacing of the teeth were affected, but no change in either density or size could be seen.

In animals having diphyodont dentitions, their size and form appear to be laid down in accord with genetic principles entirely, and are consequently little if at all influenced experimentally. On the other hand,

FIG. 39. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF CONTROL LITTER-MATE. SEE FIGS. 38 AND 40

in rodents having constantly growing incisors, the size and form of these teeth might easily be altered by influences that modify the investing tissues. The results of the present type of experimentation would seem to bear this out. My earlier study (36, 37, 38), on causes of anomalies, laid down the importance of genetic factors in the pattern of the dentition. The studies of Putnam, Teel and Benedict, and those of Reichert (144 and 145), demonstrated, as does the present one, that variations in time of eruption of the teeth and size of the jaws

might be induced by pituitary experimentation. In their studies, the teeth and jaws were apparently not examined microscopically, but there was no gross evidence of change in form or structure of the teeth or investing tissues, except in the size of the jaws. So far as I am aware, no other similar studies have been pursued.

Wolbach and Howe (201–204), Höjer and Westin (79, 196, 197), Toverud (185), and others, have described very definite changes in the

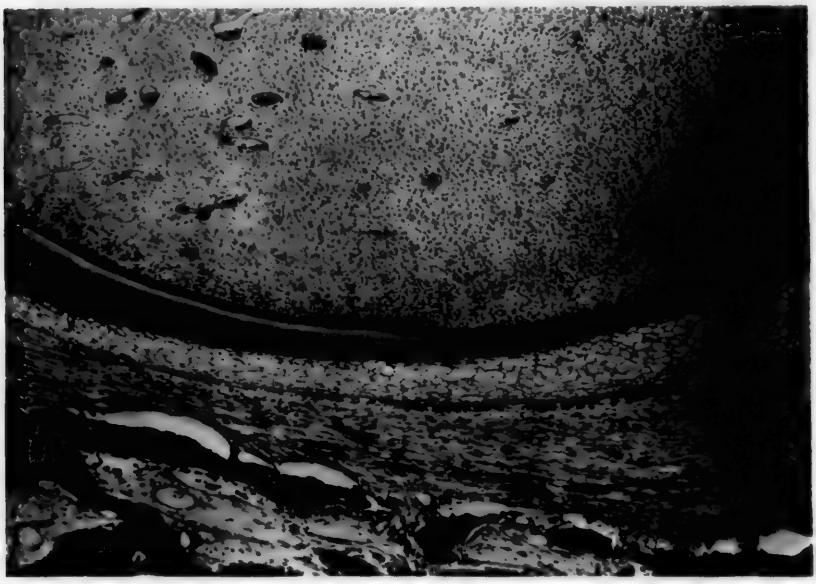

FIG. 40. PHOTOMICROGRAPH OF SIMILAR AREA AND PREPARATION FROM TOOTH OF HYPOPHYSECTOMIZED LITTER-MATE. THERE ARE NO DIFFERENCES. SEE FIGS. 38 AND 39

pulpal cells in scurvy. The odontoblasts lose their regular palisade-like arrangement and osteodentin is formed in the pulp. The dentin may actually become resorbed. May Mellanby in particular (118–120), also Marshall (112), McCollum and co-workers (109), and others, have described changes in both the hard substances of the tooth and in the surrounding bone in rickets. Erdheim (45, 46), Toyofuku (186), Gies (64), and Hammett (71), have noted marked changes in density and

texture of the rodent incisors in parathyroid experiments. The preparations obtained from the present studies have been carefully checked against each of these, but no similar changes were noted.

It is felt, again, that this points to the eruption and development of the dentition as a phenomenon of general somatic growth. Likewise, the fact that the effect on the eruption of the permanent dentition, and their growth, is about parallel in time and rate with the growth changes in the body in general, demonstrates that this is true; and that the growth-fraction of the anterior lobe stimulates growth, i.e., development of the body in general, in time and in degree, and is not in any sense specific as to organs or tissues involved.

V. SUMMARY

The present study, initiated to determine effects of the growth-fraction of the anterior lobe of the pituitary body on the teeth and their investing tissues primarily, and on other tissues and organs secondarily, demonstrated the following facts:

1. The conclusions of numerous other workers that there is, in the anterior lobe of the hypophysis, a hormone or substance not necessary to life, but essential for normal or average growth and development, has been substantiated.

2. A part of rapid growth in animals is the late retention, in the tissues, of a larger percentage of water, a retardation in fat storage, and an increase in mineral concentration.

3. One effect of experimental hypophysis-stimulated growth is a definite toxic action on the tissues and organs most susceptible to such influences.

4. The growth-fraction of the hypophysis may accelerate the rate of eruption of the dentition; and, owing to increase in the size of the jaw, may also alter the position of the teeth; but, in the case of animals having a dyphyodont type of dentition, does not change the size or form of the teeth.

VI. AUTOPSY PROTOCOLS

Autopsy, dog 4. Hypophysectomized Oct. 17, 1929. Litter-mate of dogs 5 and 6

Female fox terrier, twenty-six weeks old. Superficial examination: underdeveloped and pot-bellied. Large amount of loose, baggy skin, espe-

cially around throat; sparse, irregularly distributed hair, scaly skin eruption over most of head and body. Weight, 8 lbs., 2 oz.; at beginning, 5 lbs., 14 oz. Legs short in proportion to size; ankles enlarged and edematous. External genitalia very infantile.

Body opened by midline incision extending from sterno-clavicular notch to symphysis pubis. Considerable amount subcutaneous, mediastinal, mesenteric fat. Pericardium quite fatty; no fluid in pericardial sac. Heart weighs 23.4 gm.; no gross abnormalities or changes. Right lung weighs 21 gm.; left, 22.2 gm. Same gross description applies to each: light pink, not collapsed or boggy, few small gray mottlings on surface—also seen on sectioned surface. Spleen weighs 8.3 gm.; no gross abnormalities. Pancreas weighs 12.7 gm.; grossly normal. Kidneys weigh 26.8 gm.; glistening and dark colored, firm; no gross variations in appearance of cortex, medulla, or pelvis; capsule strips with ease. Stomach and intestinal tract normal in general; clear pink mucous membranes; contain moderate amounts partially digested food and fecal matter, respectively. Liver moderate size, light red, glistening; homogeneous texture on section; weighs 118.4 gm. Uterus, tubes, ovaries: very small, thin, light-colored.

Skull severed; cleaned of adherent soft tissues for measurement. Tongue small but rough, gray, dense. Cervical lymph nodes and thymus small, firm. Salivary glands normal. All temporary teeth in situ except two lower incisors replaced by permanent. Cuspids, permanent, barely erupting anterior to temporary cuspids still in place and firmly-set in arch. Teeth generally crowded; "tumbled" appearance. Measurement from external occipital protuberance to tip of nasal spine, 10.5 cm.; from crest of "bow" of zygoma, to same point on opposite side, 6.5 cm.; from condyloid process of mandible to symphsis mentis, 7.5 cm., either side; from cuspid prominence to cuspid prominence, 2 cm. Cranial sutures in general closed but easily made out; not dense. Marked flattening in frontal region. Brain appears normal; no evidence of hemorrhage around sella turcica. Hypophysis severed cleanly; bony fault and sella turcica filled in with loose connective tissue of embryonic type (microscopically determined).

Autopsy, dog 5. Litter-mate of 4 and 6

Female fox terrier, twenty-six weeks old. Superficial examination: normally developed and nourished; no peculiarities of hairy distribution, proportion, or external genitalia. Weight, 8 lbs., 10 oz.; at beginning, 5 lbs., 2 oz. Body opened by usual incision; moderate amount subcutaneous, mediastinal, mesenteric fat. Pleural surfaces normal, smooth, glistening. Pericardium: no changes. Heart normal; weighs 33.3 gm.

Right lung weighs 38.3 gm.; left, 42.5 gm. Both lungs: grayish mottling and foaminess on collapse; cultures of bronchosepticus obtained. Spleen weighs 20.9 gm.; grossly normal. Liver large, firm, red, somewhat bloody; weighs 188.5 gm. Kidneys firm, dark red to purple, smooth, glistening; weighs 36.7 gm.; no gross abnormalities. Stomach and intestines: no gross abnormalities; moderately distended with partially digested food and fecal matter. Ovaries, uterus, and tubes: normal appearance, but larger than those in dog 4 (supra). Thymus, lymph-nodes, thyroid, salivary glands: all grossly normal.

Head separated; freed from adherent tissues. Tongue and oral mucous membranes normal. Four of permanent incisors completely in place. Permanent cuspids erupted far, and all but one of temporary cuspids shed. Three of four permanent first molars erupting. Cranial sutures still made out with ease, but well closed. Mandible cuts with greater difficulty than that of dog 4. Dura, brain, sella turcica, hypophysis: no changes.

Autopsy, dog 6. Daily injections of Evans extract begun Oct. 24, 1929. Litter-mate of dogs 4 and 5

Female fox terrier, twenty-six weeks old. Superficial examination: large, tall, well developed, well nourished; sleek thick hair-coat; advanced development of external genitalia. Weight, 10 lbs., 2 oz.; at beginning, 4 lbs. Toe-nails extremely long and hard. Body opened as usual. Zyphoid process: much calcification. Almost no subcutaneous, mediastinal, or mesenteric fat, but large amount of thymic tissue. Pericardium and heart: grossly normal; latter weighs 62.7 gm. Right lung weighs 84.2 gm.; left, 63.2 gm.; both rather dark and dense; yield culture of bronchosepticus. Liver large, brown, firm; weighs 268.9 gm.; brown sectioned surface—distinct lobules. Pancreas, grossly normal; weighs 15.6 gm. Spleen: no abnormalities; weighs 17.4 gm. Kidneys weigh 46.5 gm.; red, apparent hemorrhagic area around pyramids not seen in other animals of group. Ovaries, uterus, tubes: grossly much larger than in other animals of group. Peritoneum: smooth, glistening; no gross evidence of pathological change from numerous intraperitoneal injections.

Head severed; soft tissues dissected away. Cervical lymph glands markedly enlarged. Thyroid, salivary glands: no gross change. Tongue greatly enlarged, ridged, rough; lacks clear normal outlines. Cephalic measurements, 12.5 × 8.5 cm. Cranial sutures only barely visible. Definite "bulging" in frontal region, distinctly suggestive of clinical condition in acromegaly. Mandible 8.5 cm. in length. Distance between cuspid eminences, 2.8 cm. Permanent cuspids all completely erupted; upper two

temporary not cast off. All of first permanent molars in place; second ones erupting. Entire dentition much further advanced than in control dog 5. Mandible: massive, teeth spaced; sections with great difficulty. Dura, brain, sella, hypophysis: no abnormality.

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Quotations Relating to "Dentistry or Stomatology"

THIS JOURNAL uses the term "dentistry" to signify the science and art of oral health service in all its local and systemic relationships. The meanings of words, which are not necessarily restricted to *etymological* significance, acquire expanded or new import in accordance with convenience and usage. Thus the term "medicine," which originally meant to remedy or cure, now also means *to make remedial or curative treatment unnecessary.* "Stomatology" is a synonym for "dentistry." We prefer the older term because its use respects both the history of dentistry and the efforts of those who have brought dentistry to its present status.—*Journal of Dental Research*, 1929, ix, p. iii.

If dentistry were merely dental mechanics, a two-year course in dental technology, based on graduation from a high school and conducted along lines similar to those for the education of optometrists, would probably afford sufficient training for dental practice, and oral health-service could be reserved for a new specialty to include oral surgery, which might be named stomatology and made analogous to ophthalmology and other specialties of medicine. But with dentistry developed into the *full service equivalence* of an oral specialty of medicine, the creation of a medical specialty of stomatology would be redundant—and there would be no occasion to substitute "stomatology" for the name established by custom.—*Carnegie Foundation's Bulletin on Dental Education*, 1926, p. 135.

The assumption that dentistry would be something more or better than it is, if all or a part of it were called "stomatology," exemplifies a readiness to attach more importance to labels than to contents, or more significance to make-believe than to reality. The term "medicine" originally meant to remedy or cure. ["*Medicina* (ars)"—healing art; "*medicina* (res)"—a remedy; "*medicus*"—of healing; also a physician.] Today "medicine," by including measures to *prevent* sickness and by throwing *etymology* overboard, means not only to remedy or cure, but also *quite the contrary*—to make remedial or curative treatment unnecessary. As medical knowledge has advanced and medical procedures have been changed in consonance, including the development of prevention and of surgery, new meanings have been imparted to the term "medicine." But instead of replacing "medicine" by a succession of words intended to indicate *etymologically* the broader or deeper modern meanings, the import of the original term has been conveniently enlarged as the scope of medical practice has expanded. Thus, the term "medicine" has come to mean more and more as *physicians*, without restricting themselves to its *etymology*, have included *more and more in its significance.* Along the same line of reasoning one sees clearly that, although *etymologically* the term "dentistry" refers only to the teeth, nevertheless logically it also comprehends the contiguous parts and their systemic relationships. Certainly by *usage* in conformity with this logic, and also with the criteria of common sense, the term "dentistry" has *acquired* the broader meaning suggested by the more detailed and lengthy term "oral health-service." By logic, usage, and convenience, the term "dentistry" has thus become the *practical* equivalent of "stomatology," which *etymologically* means the sum of scientific knowledge concerning the mouth, but *etymologically does not include the rest of the body* (although "stomatology" is now *used* by some to include systemic relationships with the mouth). This being true, we are unable to agree that "dentistry" and "dentists," which are terms that have long represented the earnest and aspiring endeavors of generations of faithful practitioners of oral health-service, should be formally replaced for *etymological* reasons by "stomatology" and "stomatologists."—*American College of Dentists*, March, 1929.

The New York Academy of Dentistry . . . without any diminution of its abiding purpose to promote intimate association and cooperation between dentists and the practitioners of all other kinds of health-service, believes that, in the interest of the patient, dentistry should be *continued* as a separately organized profession, based on systems of ethics, education, jurisprudence, and journalism that will fully meet all public needs at each stage of its evolution.—*New York Academy of Dentistry, April, 1929.*

The Dental Society of the State of New York . . . expresses the earnest conviction . . . that the most effectual development of oral health-service will be insured by the *continuance* of dentistry as a separately organized profession . . . [and] also records its unabated desire and intention to promote personal and professional accord, cooperation, and mutual helpfulness between dentists and the practitioners of medicine and all other kinds of health-service.—*Dental Society of the State of New York, May, 1929.*

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